Describe the superior vena cava.

It returns the blood from the head, neck, upper extremities, thoracic wall, and a portion of the upper part of the posterior wall of the abdomen. It is formed behind the first right costal cartilage by the *union of the two innominate veins*, and descends, with a slight convexity to the right, to the level of the third right costal cartilage, where it opens into the upper and back part of the right auricle. The lower half is within the pericardium. Its *tributaries* are the vena azygos major, pericardial, and mediastinal veins.

Describe the inferior vena cava and name the veins that enter into its formation.

It returns the blood to the heart from practically all parts of the body below the diaphragm. It is formed by the *junction of the two common iliac veins*, on the right side of the intervertebral disk between the fourth and fifth lumbar vertebræ. Passing upward on the front of the spine, where it lies to the right of the aorta, it traverses the under surface of the liver in the fissure of the vena cava, perforates the central tendon of the diaphragm, and enters the pericardium, terminating in the lower back part of the right auricle.

Describe the right and left subclavian veins.

The *subclavian vein* extends from the lower border of the first rib to a point behind the sternoclavicular articulation, where it unites with the internal jugular to form the innominate. The vein lies in front of the artery, separated from its second portion by the anterior scalene muscle. Its *tributaries* are the external and anterior jugular.

On the *right* side the right lymphatic duct empties into the subclavian vein at its junction with the internal jugular; the *left* subclavian vein receives the thoracic duct at this point; otherwise the course and relations of the vein are the same on the two sides.

Describe the internal jugular vein.

The vein is formed in the jugular foramen by the junction of the lateral and inferior petrosal sinuses. It courses down the neck, beneath the anterior border of the sternocleidomastoid muscle, accompanied first by the internal, and then by the common carotid artery, and throughout its course by the pneumogastric nerve. The vein is contained *in the same sheath with the artery and nerve*, but separated from these structures by a distinct septum. At first the vein lies behind the internal carotid artery; but as it descends it gradually passes to the outer side of the vessel and later along the outer side of the common carotid, partially overlapping the artery in front, to its termination behind the sternoclavicular articulation, where it unites with the subclavian to form the innominate.

Give the course and relations of the external jugular vein.

The vein is formed on the surface of the sternomastoid muscle, below the angle of the jaw, by the *union of the posterior auricular with the temporomaxillary* vein. It descends to the anterior part of the subclavian triangle and there terminates in the subclavian vein, after piercing the deep fascia and crossing the third portion of the subclavian artery.

STATE BOARD QUESTIONS AND ANSWERS

BY

R. MAX GOEPP, M. D.

PROFESSOR OF CLINICAL MEDICINE AT THE PHILADELPHIA POLYCLINIC; ASSISTANT VISITING PHYSICIAN TO THE PHILADELPHIA GENERAL HOSPITAL

PHILADELPHIA AND LONDON

W. B. SAUNDERS COMPANY

1908

PRINTED IN AMERICA

PRESS OF
W. B. SAUNDERS COMPANY
PHILADELPHIA

PREFACE

THE material for the present volume was selected from State Board questions asked during the past four years, the preference being given to those asked in the larger and more representative States. In sifting over this material it was found that many of the questions had been repeated several times, often in exactly the same form or with an immaterial change of wording. The list may, therefore, be regarded as fairly representative of the kind of examination questions usually propounded by State boards. Many were rejected because they were, in the author's opinion, unsuitable either in content or in wording; nor can it be said that the questions finally selected and embodied in the book are all above criticism. The original wording has been retained, and only the most obvious errors, which had probably crept in during the process of copying in the various medical journals in which the questions are published, have been corrected. While the purpose of the book is to provide a convenient compend for the use of those who wish to prepare themselves for State Board examinations, a certain order has been adopted in the arrangement of the questions, and a few simple and obvious questions have been interpolated here and there in order to maintain the continuity of the subject.

The limits of the volume have not permitted more than a condensed answer to each question, and for didactic expositions the student must consult the larger text-books. No attempt has been made to indicate the sources of information, and, as no originality is claimed, definitions have been taken freely from standard text-books, often without any change of wording.

I wish to acknowledge my obligations to Dr. William R. Nicholson, Professor of Gynecology in the Philadelphia Polyclinic, for the section on Obstetrics and Gynecology; to Dr. Daniel W. Fetterolf, Demonstrator of Chemistry in the University of Pennsylvania, for the section on Chemistry, and to Dr. George M. Dorrance, Demonstrator of Applied Anatomy, University of Pennsylvania, Dental Department, who prepared the answers to the questions on Anatomy and Surgery. My thanks are due also to Dr. Oscar H. Wilson for assistance in the preparation of some of the manuscript. As for the publishers, who relieved me of the work of collecting the questions, I cannot express my thanks too heartily for their valuable aid and encouragement, which materially lightened the labor of an arduous and exacting undertaking.

R. M. G.

PHILADELPHIA, MAY, 1908.

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STATE BOARD QUESTIONS AND ANSWERS

CHEMISTRY AND PHYSICS

PHYSICS

Define physics.

Physics is the science of matter and energy.

Define matter.

Matter is anything which occupies space and is perceptible to the senses.

Name the various states in which matter may exist.

Solid, liquid, gaseous, and Crooks' or radiant state.

Explain the difference between a (a) solid, (b) liquid, (c) gas.

(a) In a solid the attraction of aggregation is exerted to such an extent as to cause close union of the molecules, preventing their free movement and producing a definite form.

(b) In a liquid the attraction of aggregation exerted is not sufficient to prevent free movement of the molecules among themselves, therefore, it can assume any form which may be imposed upon it by the surrounding conditions.

(c) In a gas the attraction of aggregation seems to be absent, the molecules being self-repellent. A gas has no free surface and occupies any space within which it may be confined.

Name the essential or physical properties of matter.

States of aggregation, tenacity, porosity, expansibility, malleability, ductility, elasticity, compressibility, and indestructibility.

Prove the indestructibility of matter.

Wood, which is composed of C, H, and O, when completely burned, is changed into CO_2 and H_2O, which contain all the C, H, and O originally present in the wood, with the quantity of O consumed from the air required to bring about the change.

Define and give examples of the three varieties of attraction.

(a) *Attraction of gravitation* (mass attraction) is the force tending to draw masses of all kinds of matter together. *Example:* The falling from a tree of an apple, pear, or other fruit to the earth.

(b) *Attraction of aggregation* (homogeneous attraction, cohesion) is the attraction exerted between molecules of similar kind. *Example:* A mass of water exists only because of the attraction of aggregation between the minute molecules of water.

(c) *Heterogeneous attraction* (adhesion) is the attraction exerted between molecules of dissimilar kind. *Example:* Water adheres to wood.

Define malleability, porosity, and expansibility. Give an example of each.

Malleability is that property possessed by metals which renders them susceptible of being rolled or hammered out into thin sheets. *Examples:* gold, silver, platinum.

Porosity is that property of matter by virtue of which there are unfilled spaces (pores) among the molecules. *Example:* Water may be forced through the pores of wood or cast-iron.

Expansibility is that property of matter by virtue of which the volume of any given mass may be increased. *Example:* An iron ball, which just passes through an iron ring when cold, will not when heated.

By what forces can (a) a solid be changed into a liquid or a gas, (b) a gas be changed into a liquid or a solid?

(a) By heat or by lessened pressure.

(b) By cold or by increased pressure.

(a) Define capillary attraction. (b) Why is it so called? (c) Mention some familiar examples.

(a) It is the mutual action of solids and liquids, by which the surface of the liquid is raised or lowered.

(b) Because solids in the form of hair-like (*capillus*, a hair) tubes show it in the highest degree.

(c) If a piece of glass be inserted in water, the liquid will rise a little distance above its surface alongside the glass. It rises because the attraction between molecules of glass and those of water is stronger than that between molecules of water. If a piece of glass be inserted in mercury, the liquid will sink below the level. It sinks because the attraction between molecules of glass and those of mercury is weaker than that between the molecules of mercury. The oil in a lamp passes up the wick, the sap flows through vegetable fiber by capillary attraction.

(a) What is weight? (b) Name the various systems of weight.

(a) Weight is an arbitrary measure of the force of gravitation.

(b) Troy or apothecaries', avoirdupois, and metric or decimal.

Describe the metric system of weights and measures.

The *unit of linear measure*, on which the system is based, is the meter, which is equal to one forty-millionth of the earth's circumference around

the poles. It is divided into ten equal parts called *decimeters*, each of these again divided into ten parts called *centimeters*, and each of these into ten parts called *millimeters*. The meter is 39.37 inches in length.

The unit of capacity, the *liter*, is the cube of a decimeter or tenth part of a meter. It contains 1000 cubic centimeters and is nearly equivalent to the English quart.

The unit of weight, the *gram*, is the weight of one cubic centimeter of distilled water at 4° C.

The subdivisions in the case of the liter and the gram are also expressed by means of the Latin prefixes *deci*, *centi*, and *milli;* multiples are expressed by the Greek prefixes *deca*, *hecto*, and *kilo*. Thus, one *decameter* equals 10 meters; one *hectoliter* equals 100 liters; and one *kilogram* equals 1000 grams. The kilogram is equivalent to 2.2 pounds avoirdupois.

(a) Express in cubic centimeters of distilled water the value of one fluidounce apothecaries' weight. (b) How many minims does a cubic centimeter contain?

(a) About 30 cubic centimeters.
(b) About 16 minims.

How many cubic centimeters represent one fluidram apoth=ecaries' measure?

About 4 c.c.; more accurately, 3.75 c.c.

Express the equivalent of one liter and one meter in units of another system, and of one gram in units of Troy weight.

One liter =33.81 fluidounces, apothecaries' measure.
One meter=39.37 inches.
One gram =15.432 Troy grains.

Express the equivalent in the metric system of the following weights: 1, 5, 10, and 15.5 grains, and 1 ounce.

1	grain	=	0.065 gm.
5	grains	=	0.324 gm.
10	grains	=	0.650 gm.
15.5	grains	=	1.000 gm.
1	ounce	=	31.100 gm.

Express the equivalent in apothecaries' measure and in the metric system of the following: a teacupful, wineglassful, tablespoonful, dessertspoonful, teaspoonful, and minim.

A teacupful	=f℥iv	=120 cc.
A wineglassful	=f℥ij	= 60 cc.
A tablespoonful	=fʒiv	= 15 cc.
A dessertspoonful	=fʒij	=7.5 cc.
A teaspoonful	=fʒj	=3.75 cc.
A minim	=0.95 gr.	=0.061 cc.

State approximately the equivalent (a) in grains of one gram, (b) in fluidounces of one liter, (c) in inches of one meter, (d) the number of minims in one cubic centimeter.

(a) 15.5; (b) 34; (c) 39.4; (d) 16.

Define specific gravity. Give a method of determining the specific gravity of a solid substance insoluble in, and heavier than water.

Specific gravity is the relative weight of equal volumes of different substances, one being used as a standard.

Find the weight of the substance in air and then in water (under standard conditions), and divide its weight in air by its loss of weight in water; the quotient will be the specific gravity. *Example:*

Weight of iron in air = 115.56 gr.
Weight of iron in water = 100.08 gr.

Loss of weight in water = 15.48 gr. = the weight of the volume of water displaced, hence—

$115.56 \div 15.48 = 7.46$ = the specific gravity of iron.

What is the unit of comparison in determining the specific gravity of (a) solids and liquids; (b) of gases?

(a) Pure water at 4° C. and a barometric pressure of 760 millimeters, according to the French system; or 62° F. and 30 inches barometric pressure, according to the English system. The specific gravity of solids and liquids is usually taken at a temperature of 15.5° C. (60° F.).

(b) Air or hydrogen at 0° C. and 760 millimeters, according to the French system; or 60° F. and 30 inches pressure, according to the English system.

Describe (a) a hydrometer, (b) a pyknometer. Name some varieties of hydrometers.

(a) A *hydrometer* (densimeter) is an instrument employed for determining the specific gravity (density) of liquids. It consists of a graduated glass tube, with one or two bulbs at the lower end loaded with mercury or shot.

(b) A *pyknometer* is a glass specific gravity bottle having a thermometer and a very narrow or capillary tube. Varieties: alcoholometer, lactometer, urinometer.

Describe a urinometer and give the precautions to be observed in its use.

A *urinometer* is a hydrometer with a scale usually ranging between 1000 and 1060, used for determining the specific gravity of urine. The urine to be examined must be kept at 15.5° C. (60° F.); the urinometer freed from all adherent bubbles of air and not allowed to touch the sides of the jar. The specific gravity is then read off on the scale, reading from the base of the meniscus where the stem cuts the surface of the liquid. A correction must be made for any variation of temperature. For an increase of each 3° C. above 15.5° C. the specific gravity must be lowered one degree, and for a decrease of each 3° C. it must be increased one degree.

How would you determine the specific gravity of a liquid?

By placing a hydrometer in the liquid (under standard conditions) and noting the depth to which it sinks by the markings on the stem. The

reading which represents the specific gravity, is taken at the base of the meniscus, where the stem cuts the surface of the liquid (see page 14).

(a) What is heat and (b) what is the source of animal heat?

(a) Heat is molecular kinetic energy.

(b) The appropriation of the potential energy stored in foods and the various chemical changes occurring during the processes of metabolism.

How is sensible heat of the human body measured?

By means of a thermometer.

(a) Describe a thermometer and (b) explain the difference between the Fahrenheit, centigrade, and Réaumur thermometers.

(a) A thermometer is an instrument for measuring temperatures. It consists of a glass tube having a fine, uniform bore, with a bulb at one end. The bulb and part of the stem are full of mercury. The space in the tube above the mercury is a vacuum (Torricellian vacuum) and the end of the tube is hermetically sealed. A scale to measure the expansion or contraction of the thread of mercury is attached to the stem or engraved on the stem itself.

(b) The melting-point of ice (freezing-point of water) is marked 32 on the Fahrenheit scale, and 0 on the centigrade and Réaumur scales. The boiling-point of water is marked 212 on the Fahrenheit scale, 100 on the centigrade scale, and 80 on the Réaumur scale. The Fahrenheit has 180 degrees between the freezing and the boiling-point of water, the centigrade 100 degrees, and the Réaumur 80 degrees; hence—

$9°$ F. $= 5°$ C.; $9°$ F. $= 4°$ R.

(a) What temperature Fahrenheit is equivalent to a temperature of 28° centigrade? (b) What is the equivalent in centigrade degrees of 120 Fahrenheit and (c) of 98.6° F?

(a) $28°$ C. $\times 9 = 252 \div 5 = 50.4 + 32 = 82.4°$ F.
$28°$ C. $= 82.4°$ F.

(b) $120°$ F. $- 32 = 88 \times 5 = 440 \div 9 = 48.88°$ C.
$120°$ F. $= 48.88°$ C.

(c) $98.6°$ F. $- 32 = 66.6 \times 5 = 333 \div 9 = 37°$ C.
$98.6°$ F. $= 37°$ C.

(a) What is a fever or clinical thermometer? (b) How is it made and graded?

(a) It is a small glass thermometer, having a constriction in the lumen of the capillary tube immediately above the mercurial bulb. The constriction prevents the fall of the mercury by its own weight, while cooling and contracting, thereby retaining the temperature registered.

(b) It is made in the same manner as other thermometers, by certain steps:

1. Calibrating the tube.
2. Filling the tube.
3. Curing the tube.
4. Graduating the thermometer.

The usual method of graduating is from 94° to 110° F., each degree being divided into five equal spaces.

Describe and state the uses of (a) the thermometer, (b) the barometer, (c) the hygrometer.

(a) See page 15.

(b) A *barometer* in its simplest form is a strong, straight glass tube, about 33 inches (800 mm.) in length, and closed at one end. This tube is filled with mercury, and the open end is placed beneath the surface of mercury in a cistern. The space in the tube above the mercury is a Torricellian vacuum. The mercury in the tube falls to a point about 30 inches (760 mm.) from the surface of the mercury in the cistern. It is an instrument by which changes in the pressure of the atmosphere can be detected and measured. It is also used for measuring altitudes.

(c) *Hygrometers* are made of various forms. One of the simplest consists of two thermometers (wet and dry bulb thermometers, called *psychrometers*), mounted side by side a short distance apart, one having a dry bulb, and the other a bulb covered with muslin and kept moist by capillary action through conducting threads of lamp-wick or cotton from a vessel of water below. The dry bulb indicates the temperature of the air itself; while the wet bulb, cooled by evaporation, shows usually a lower temperature (*dew-point*), according to the degree and rapidity of evaporation. The hygrometer is used to measure indirectly the amount of aqueous vapor (humidity) in the atmosphere and to determine the dew-point of any specimen of air. A certain form is also employed to determine the relative amount of perspiration from the skin.

What is the boiling-point (Fahrenheit) of (a) water, (b) alcohol, (c) mercury, (d) ether?

(a) 212°; (b) 172.4°; (c) 674.6°; (d) 96°.

What is freezing? State the freezing-point (Fahrenheit) of (a) water, (b) alcohol, (c) mercury.

Freezing is the change of a liquid to the solid state by the reduction of the temperature

(a) 32°, (b) −202.9°, (c) −37.9.

What effect does freezing have upon bodies, as a rule? What on water?

Freezing causes contraction and an increase in the weight of a given mass of matter by the compaction of the molecules. Freezing of water causes *expansion* and a decrease in the weight of a given mass.

Define latent heat and specific heat.

Latent heat is the heat present in a substance not manifesting itself as temperature, but required to retain it in its state of aggregation. *Specific heat* is the relative amount of heat required to raise equal weights of different substances through the same range of temperature, one being taken as the standard.

Name (a) two substances that are fusible, (b) two that are volatilized by heat, (c) two that are unaffected by heat.

(a) Iron and lead, (b) sulphur and iodin, (c) carbon and silicon.

What is meant by the terms (a) effervescence, (b) efflor=escence and (c) deliquescence?

(a) *Effervescence* is the agitation or ebullition which is produced by the escape of a gas through a liquid, independently of the heat of the mixture; such, for instance, as results from the mixture of an acid and a carbonate.

(b) *Efflorescence* is the conversion of a solid substance into a pulverulent state by exposure to the air, due to the loss of water of crystallization. *Example:* Crystalline magnesium sulfate exposed to air becomes a white powder.

(c) *Deliquescence* is the conversion of a solid salt into the liquid form by the absorption of moisture from the air, as occurs when gold chlorid, calcium chlorid, magnesium chlorid or cobalt nitrate is exposed to the air.

Define an amorphous substance.

An amorphous substance is a solid of noncrystalline character.

Define evaporation, distillation, filtration, saturation, and sublimation.

Evaporation is the passing of a liquid into the state of vapor. This process occurs at all temperatures.

Distillation is the vaporization of a liquid by the application of heat, and recondensation into the liquid state by conducting the vapor through a cooled tube or vessel.

Filtration is the process of separating liquids from solids by means of some porous membrane or septum.

Saturation is the incapacity of a liquid to retain any more of the dissolved substance after it has exercised its powers of solvency to its utmost extent.

Sublimation is the process of separating a volatile solid substance from one which is not volatile by the application of heat.

What is dialysis and how may a dialyzer be constructed?

Dialysis is the process of separating crystallizable (*crystalloidal*) from noncrystallizable (*colloidal*) substances by suspending a mixture of both upon a porous diaphragm which has its under surface in contact with water. A dialyser may be constructed with two circular glass vessels, the one larger than the other, so that the smaller may be suspended in the larger, the bottom of the smaller vessel being composed of some porous substance such as parchment paper.

ELECTRICITY

Define electricity.

The exact nature of the electricity which makes itself evident in so many ways has never been determined. Provisionally, it may be regarded as that which is transferred from one body to another body when the two become oppositely electrified.

What is electrolysis?

Electrolysis is the process of chemical decomposition of certain compounds in solution, such as acids or salts of the metals, and also of some fused compounds, when a current of electricity flows through them.

What is an electrolyte?

An electrolyte is a substance capable of carrying a current of electricity.

Define a volt, a watt, a coulomb, an ohm, an ampere, and a milliampere.

A *volt* is the unit of electromotive force.

A *watt* is the power of an electric current of one ampère at one volt.

A *coulomb* is the quantity of electricity conveyed by the current of an ampère per second. For the evolution of 1.01 gram of hydrogen 96.54 coulombs must pass through the electrolyte.

An *ohm* is the unit of resistance offered to a current of electricity by a pure copper wire one millimeter in diameter and 48.61 meters long at 18.3° C.

An *ampere* is the unit of current strength carrying one coulomb per second.

A *milliampere* is the one-thousandth part of an ampère. From 1 to 100 or more milliampères may be administered to a patient for medicinal purposes.

Define galvanic (voltaic) electricity.

A *galvanic* current of electricity is the result of chemical action having but low potential with large quantity. Such a current is produced when a plate of zinc and one of carbon, joined by a wire, are partly immersed in dilute sulfuric acid, without being in contact. The current passes from the most active chemical substance (zinc) through the fluid to the less active (carbon).

Define the faradic current of electricity. How is it produced?

The *faradic* or *induced* current is an interrupted, or alternating current of high potential but small quantity; it is produced by the induction of a current into a coil of long, thin, insulated wire surrounding another coil of short, thick, insulated wire, through which a galvanic current alternately flows.

Describe a method of producing an electric current by chemical action.

See second question above.

State the chemical changes produced in a galvanic cell while in action.

In a galvanic cell such as described above the sulfuric acid is ionized into H_2 and SO_4 ions, the H_2 ions passing off at the negative pole, and a portion of the SO_4 ions uniting with the zinc to form zinc sulfate, which is held in solution in the water; another portion is ionized into SO_3 and O ions, the O ions passing off at the positive pole. The SO_3 ions unite with the water to reproduce H_2SO_4.

Describe an electric battery.

An electric battery consists of two or more galvanic cells joined together:

1. In parallel or multiple arc. In this form all the zinc plates are joined together, and all the carbon plates connected among themselves by means of a separate wire.

2. In series. In this form the zinc plate of one cell is joined to the carbon plate of the next cell by means of a wire.

Describe a Leyden jar.

It is a glass jar, coated inside and out with tin foil to within a few inches of the top, with a dry, hard-wood cover, through which passes a brass rod surmounted by a brass ball, with a chain reaching from the lower end to the bottom. It is a condenser, used for accumulating a large quantity of electrification on a small surface by induction.

Describe the incandescent electric light, and explain its use as an aid to diagnosis in medical and surgical practice.

It is the incandescence produced by a current of electricity when passed through a thin, infusible conductor of high resistance, such as a thin filament of carbonized bamboo, contained in a glass bulb exhausted of air. It is of considerable value to the physician and surgeon for illuminating cavities and passages which cannot be otherwise lighted, such as the bladder, urethra, vagina, rectum, larynx, and stomach.

Explain the method of producing Röntgen or X=rays and mention some of their properties and uses in medicine.

The *Röntgen* or *x-rays* are produced in a high-vacuum glass tube when the cathode rays are well developed and suddenly stopped by their impact upon a metallic surface, such as platinum. They have the property of penetrating opaque bodies. They pass freely through wood, thick books, and plates of ebonite. Metals are more opaque than other substances and bones more than flesh; hence, when exposed to these rays, they produce shadows. They have the power of lighting up many fluorescent substances, and of producing chemical action on photographic plates, as shown by pictures (*skiagraphs*) of the bony structures of animals. They cannot be reflected, refracted, dispersed, polarized, nor deflected by a magnet.

In medicine they are used as an aid in diagnosis and for their palliative and curative properties upon certain diseases and growths, such as lupus, keloids, and malignant tumors.

CHEMISTRY

The subject of chemistry is divided into *inorganic*, *organic*, and *physiologic* for rapid and convenient reference.

Inorganic

Define chemistry.

Chemistry is the science which treats of the properties and composition of substances, their changes in composition, and the phenomena attending such changes.

Give the difference between a physical and chemical change, with an example of each.

A *physical* change is one occurring in a mass of matter in which the substance retains its original properties and composition. *Example:* Water changing into ice or steam.

A *chemical* change is one occurring in the molecules of matter in which the substance or substances lose their identity by the formation of new substances.

Example: Paper when burned yields carbon dioxid (CO_2) and water (H_2O), with some charcoal (C).

Designate the following as chemical or physical changes: (a) The conversion of water into steam, (b) the souring of milk, (c) dissolving salt in water, (d) decay of wood, (e) decomposition of sunlight by means of a prism.

(a) Physical; (b) chemical; (c) physical; (d) chemical; (e) physical.

Differentiate (a) a mass of matter, (b) a chemical compound and (c) an elementary body. Give an example of each.

(a) A mass of matter is an aggregation of either elementary or compound molecules.

Example: A goblet of water or a grain of sand.

(b) A *chemical compound* is matter in which the molecules are composed of dissimilar atoms and can be simplified into its ultimate atoms.

Example: Sodium chlorid (NaCl) or potassium nitrate (KNO_3).

(c) An elementary body (*element*) is matter in which the molecules are composed of similar atoms and cannot be simplified.

Example: Hydrogen (H—H). Oxygen (O=O).

How many elements are there and by what simple means are they represented?

There are about seventy-nine elements and they are represented by means of symbols.

Define a chemical symbol and state what it represents?

A *symbol* is the initial letter or the initial letter, combined with some other letter, of the name of an element, as C for carbon, Cl for chlorin.

The symbol represents the element, the atomic weight, and the valence of that element, as: O represents oxygen, 16 parts by weight and the valence of 2.

Give the symbols of the following elements: (a) gold, (b) silver, (c) iron, (d) arsenic, (e) potassium (kalium).

(a) Au; (b) Ag; (c) Fe; (d) As; (e) K.

Give the symbols of (a) antimony, (b) zinc, (c) boron, (d) mercury, (e) calcium.

(a) Sb; (b) Zn; (c) B; (d) Hg; (e) Ca.

Define valence, quantivalence, equivalence, atomicity, and give the meaning of the words monad (univalent), diad (bivalent), triad (trivalent), tetrad (quadrivalent), pentad (pentivalent), and hexad (hexivalent). Give an example of each.

Valence is the number of atoms of hydrogen which once the atomic weight of an element will combine with or displace from its combinations. *Example:* Once the atomic weight (35.5 parts) of chlorin will unite with once the atomic weight (1 part) of hydrogen to form hydrochloric acid (HCl). Valence of Cl is one or *monad.* Once the atomic weight (39.1 parts) of potassium will displace once the atomic weight (1 part) of hydrogen from hydrochloric acid to form potassium chlorid (KCl).

Monad, an element or group of elements having a combining power equal to once the atomic weight of hydrogen. *Example:* Chlorin as given above.

A *diad* is equal to two atoms of hydrogen; *triad* to three; *tetrad* to four; *pentad* to five; *hexad* to six.

Examples: Diad, oxygen, once the atomic weight will combine with twice the atomic weight of hydrogen to form water (H_2O); triad, nitrogen, as NH_3; tetrad, carbon as CH_4; pentad, phosphorus as PCl_5; hexad, Wolfram (tungsten) as $WoCl_6$. In the PCl_5 and $WoCl_6$ the Cl atoms represent the same number of hydrogen atoms which have been displaced from HCl by once the atomic weight of P and Wo respectively.

State the valence of the following radicals: (CN), (HO or OH), (NO_2), (CO_2), (HC).

CN, monad; HO, monad; NO_2, monad; CO_2, diad; HC, triad.

Describe and illustrate (a) monobasic acid and salt, (b) dibasic acid and salt, (c) tribasic acid and salt.

(a) An acid containing in its molecule one replaceable atom of hydrogen, as HNO_3, nitric acid. A salt produced from a monobasic acid in which the H has been replaced by a metal or electro-positive (cationic) radical, as $NaNO_3$, sodium nitrate.

(b) An acid having two replaceable atoms of hydrogen in its molecule, as H_2SO_4, sulfuric acid. A salt produced by the replacement of the H from a dibasic acid, as Na_2SO_4, sodium sulfate.

(c) An acid having three replaceable atoms of hydrogen in its molecule, as H_3PO_4, phosphoric acid. A salt produced by the replacement of the H from a tribasic acid, as K_3PO_4, basic potassium phosphate.

What is a compound radical? Give three examples of compound radicals, indicating the valence of each.

A compound radical (radical, complex, residue or rest) is a chemical compound composed of two or more elements, capable of acting as an element. *Examples:* NO_3, valence 1; SO_4, valence 2; PO_4, valence 3.

What is a formula, and how many kinds are employed to show the composition of compounds?

A *chemical formula* is the representation of a compound by means of the symbols of the elements composing it. Four kinds of formula are employed: *empiric*, *molecular*, *rational*, and *graphic* (structural or constitutional).

Define empiric, molecular, rational, and graphic formulas, giving an example of each.

An *empiric* formula is the simplest expression by formula of the composition of a compound. It represents the least atomic proportions of the elements composing the compound. *Example:* HO for hydrogen peroxid.

A *molecular* formula is that formula which expresses a quantity by weight of a compound equal to twice its specific gravity in the gaseous state compared with hydrogen. *Example:* H_2O for water.

A *rational* formula attempts to express the arrangement of the elements in the molecule of a compound. *Example:* $HC_2H_3O_2$ or CH_3COOH for acetic acid.

A *graphic* (structural, constitutional) formula attempts to express the arrangement of the elements in the molecule of a compound by means of bonds. *Example:*

$$\begin{array}{c} \mathrm{H} \\ | \\ \mathrm{H-C-H} \\ | \\ \mathrm{H} \end{array} \text{ for methane, } CH_4.$$

Give the graphic formula of sulfuric acid, representing S as a diad, also as a hexad.

$$\begin{array}{l}\mathrm{H-}\\ \mathrm{H-}\end{array}\!\mathrm{SO_4}; \qquad \begin{array}{l}\mathrm{H-O-}\\ \mathrm{H-O-}\end{array}\!\mathrm{S}\!\begin{array}{l}\mathrm{{/\!\!/}O}\\ \mathrm{{\backslash\!\!\backslash}O}\end{array}.$$

Write the graphic formula for (a) hydrogen peroxid, (b) ammonium chlorid, (c) mercurous chlorid, (d) ammonia, (e) phosphoric acid, (f) mercuric chlorid.

(a) $\mathrm{H-O-O-H}$; (b) $\begin{array}{c}\mathrm{H}\\ |\end{array}$ $\begin{array}{l}\mathrm{H\backslash}\\ \mathrm{H/}\end{array}\!\mathrm{N-Cl}$; $\begin{array}{c}|\\ \mathrm{H}\end{array}$ (c) $\mathrm{Hg-Cl}$;

(d) $\mathrm{H-N}\begin{array}{l}\mathrm{/H}\\ \mathrm{-H}\end{array}$; (e) $\begin{array}{l}\mathrm{H-O-}\\ \mathrm{H-O-}\\ \mathrm{H-O-}\end{array}\!\mathrm{P}{=}\mathrm{O}$; (f) $\mathrm{Cl-Hg-Cl}$.

Give the graphic formula of (a) water, (b) nitric acid, (c) marsh gas, (d) calcium hydrate (hydroxid).

(a) $\mathrm{H-O-H}$; (b) $\mathrm{H-O-N}\begin{array}{l}\mathrm{{/\!\!/}O}\\ \mathrm{{\backslash}O}\end{array}$; (c) $\begin{array}{c}\mathrm{H}\\ |\\ \mathrm{H-C-H}\\ |\\ \mathrm{H}\end{array}$; (d) $\mathrm{Ca}\begin{array}{l}\mathrm{/O-H}\\ \mathrm{\backslash O-H}\end{array}$.

Give the formula for (a) calcium carbonate, (b) sulfurous acid, (c) acetic acid, (d) water, (e) cupric sulfate, (f) sodium sulfate, (g) potassium nitrate, (h) ammonium chlorid.

(a) $CaCO_3$; (b) H_2SO_3; (c) $C_2H_4O_2$; (d) H_2O; (e) $CuSO_4$; (f) Na_2SO_4; (g) KNO_3; (h) NH_4Cl.

Give the formula for (a) mercuric chlorid, (b) mercurous chlorid, (c) cupric nitrate, (d) zinc sulfate, (e) ferric chlorid.

(a) $HgCl_2$; (b) $HgCl$; (c) $Cu\,(NO_3)_2$; (d) $ZnSO_4$; (e) $FeCl_3$.

Give the formulas and names of five acid and five salt compounds used in medicine.

HNO_3, nitric acid; HCl, hydrochloric acid; H_2SO_4, sulfuric acid; $HC_2H_3O_2$, acetic acid; H_3PO_4, orthophosphoric acid.

$NaCl$, sodium chlorid; KI, potassium iodid; NH_4Cl, ammonium chlorid; $MgSO_4$, magnesium sulfate; $HgCl_2$, mercuric chlorid.

Write the formula of (a) common salt, (b) hydrogen dioxid, (c) hydrogen sulfid, (d) carbonic anhydrid, (e) calcium sulfate, (f) boric acid.

(a) $NaCl$; (b) H_2O_2; (c) H_2S; (d) CO_2; (e) $CaSO_4$; (f) H_3BO_3.

What is the chemical composition of ordinary alum?

It is a double salt composed of ammonium sulfate and aluminium sulfate containing several molecules of water of crystallization. The formula is $(NH_4)_2SO_4Al_2(SO_4)_3+24H_2O$ or $NH_4Al(SO_4)_2+12H_2O$.

Give the chemical composition by formula of each of the following: (a) lunar caustic, (b) green vitriol, (c) muriatic acid, (d) caustic potash (kali caustic), (e) carbonic acid gas, (f) caustic soda (natri caustic).

(a) $AgNO_3$; (b) $FeSO_4$; (c) HCl; (d) KOH; (e) CO_2; (f) $NaOH$.

What is the composition of baking powders? How are they adulterated? What is their mode of action?

They are mixtures of sodium bicarbonate with a weak acid or an acid salt, such as potassium bitartrate.

Adulterants: alum, acid calcium phosphate, calcium sulfate, starch and flour.

They act by the liberation of CO_2 gas, causing "aeration" or "raising" of the mass of dough.

The following equation shows the reaction which takes place:

$$NaHCO_3+KHC_4H_4O_6=KNaC_4H_4O_6+H_2O+CO_2.$$

Give the formula and chemical name of the following substances, indicating those which are soluble in water: (a) nitre (saltpeter), (b) Chili saltpeter, (c) Epsom salt, (d) Paris green, (e) aqua fortis, (f) gypsum, (g) Glauber's salt, (h) Rochelle salt.

(a) KNO_3, Potassic nitrate, soluble; (b) $NaNO_3$, sodic nitrate, soluble; (c) $MgSO_4+7H_2O$, magnesium sulfate, soluble; (d) $Cu(C_2H_3O_2)_2 3CuO_4As_2$, cupric aceto-arsenite, insoluble; (e) HNO_3, hydric nitrate or nitric acid, soluble; (f) $CaSO_4+2H_2O$, calcic sulfate, insoluble; (g) $Na_2SO_4+10H_2O$, sodic sulfate, soluble; (h) $KNaC_4H_4O_6+4H_2O$, potassic-sodic tartrate, soluble.

Give the chemical name and formula of (a) common table salt, (b) marble, (c) plaster of Paris, (d) borax, (e) blue vitriol, (f) soot, (g) vinegar, (h) verdigris.

(a) Sodium chlorid, NaCl; (b) calcium carbonate, $CaCO_3$; (c) anhydrous calcium sulfate, $CaSO_4$; (d) sodium biborate, $Na_2B_4O_7+10H_2O$; (e) cupric sulfate, $CuSO_4+5N_2O$; (f) carbon, C; (g) dilute acetic acid, $HC_2H_3O_2$; (h) basic cupric acetate, $Cu(C_2H_3O_2)_2Cu(OH)_2+5H_2O$, is the approximate composition.

Give the chemical name and formula of (a) tartar emetic, (b) sugar of lead, (c) copperas.

(a) Potassium antimony tartrate, $(K(SbO)C_4H_4O_6)_2+H_2O$; (b) plumbic acetate, $Pb(C_2H_3O_2)_2+3H_2O$; (c) ferrous sulfate, $FeSO_47H_2O$.

Give the symbol, atomic weight, and valence of five non-metals and of five metals.

Cl, 35.5, monad($'$); O, 16, diad($''$); N, 14, triad($'''$); C, 12, tetrad($''''$); P, 31, triad or pentad($'''$,$'''''$).

Na, 23, monad($^{\cdot}$); Ba, 137, diad($^{\cdot\cdot}$); Fe, 56, triad($^{\cdot\cdot\cdot}$); Pt, 195, tetrad($^{\cdot\cdot\cdot\cdot}$); Hg, 200, monad or diad($^{\cdot}$,$^{\cdot\cdot}$).

Give the technical name and formula of (a) aqua regia, (b) oil of vitriol, (c) green vitriol.

(a) Nitrohydrochloric acid, (b) sulfuric acid, H_2SO_4; ferrous sulfate, $FeSO_4+7H_2O$.

What is an ion? Give example.

An *ion* is an electrically charged element or group of elements. *Example:* When sodium chlorid is dissolved in water it is partially dissociated into ions of sodium and chlorin. NH_4Cl heated to a high temperature dissociates into ions of NH_3 and HCl.

How many forms of ions?

There are two forms: *cations* (+), those elements or group of elements which carry cationic electric charges and are attracted to the cathode or negative pole of an electric battery, and *anions* (−), those which carry anionic electric charges and are attracted to the anode or positive pole.

By what means are cations and anions designated?

Cations are designated by means of a dot ($^{\cdot}$), and anions by means of a dash or accent ($'$), each dot or dash representing a valence of one.

Example: $K^{\cdot}$, potassium, monad cation; $Ba^{\cdot\cdot}$, barium, diad cation; Cl', chlorin, monad anion; N''', nitrogen, triad anion.

State the atomic theory.

Matter is composed of minute particles, called *molecules*, and each of these molecules is made up of smaller, indivisible particles, called *atoms*, which according to fixed laws unite with each other in definite proportions by weight.

Define atomic weight and equivalent weight. Give an example of each.

Atomic weight is the specific gravity of an element in its gaseous state, compared with hydrogen—except *mercury, cadmium, helium,* and *argon,* the atomic weight of which is *twice* the specific gravity, and *arsenic* and *phosphorus,* the atomic weight of which is *one-half* the specific gravity.

(b) The atomic weight of an element is that weight which, when multiplied by the specific heat of the element, yields a product of about 6.4. *Example:* The specific gravity of oxygen is 16, compared with hydrogen. If the specific heat of oxygen (0.4) be multiplied by 16, it will yield a product of about 6.4; therefore 16 is the atomic weight of oxygen.

(c) Atomic weight is the smallest quantity by weight of an element that is present in the molecule of any of its compounds. *Example:* The smallest quantity of chlorin present in a molecule of sodium chlorid, or in a molecule of hydrochloric acid, is 35.5 parts by weight, therefore 35.5 is the atomic weight of chlorin.

Equivalent weight is the least weight of an element that will combine with, or displace one part by weight of hydrogen. *Example:* Water, H_2O, contains 2 parts by weight of hydrogen and 16 parts by weight of oxygen; therefore 1 part by weight of hydrogen is combined with 8 parts by weight of oxygen, consequently 8 is the equivalent weight of oxygen.

Define molecular weight and molecular volume, giving an example of each.

The molecular weight of an element or compound is equal to twice its specific gravity in the gaseous state compared with hydrogen; or, it is the sum of the atomic weights of the elements contained in a molecule of a substance. *Example:* O_2, molecular weight 32; H_2SO_4,=98.

Molecular volume is the volume occupied by once the molecular weight of an element or compound in its gaseous state compared with hydrogen. *Example:*

32 gm. of O = 22.32 liters (22,320 cc.)
18 gm. of H_2O = 22.32 liters (22,320 cc.)
2 gm. of H = 22.32 liters (22,320 cc.)

Define (a) an atom, (b) a molecule, (c) a mechanical mixture, and (d) a chemical compound.

(a) An *atom* is, theoretically, the smallest particle of matter that can exist only in chemical combination.

(b) A *molecule* is, theoretically, the smallest particle of matter that can exist alone.

(c) A *mechanical mixture* consists of two or more substances each of which retains its individual characteristics and may be separated from the others by mechanical means.

(d) See page 20, 3rd question, (b).

Define chemical affinity (chemical force, or attraction chemism), and give an example.

It is the affinity or attraction which exists between the atoms of certain

substances acting through inappreciable distances to form new compounds. *Example:*

$$H + Cl = HCl.$$
$$HCl + NH_3 = NH_4Cl.$$

Explain an experiment to prove that chemical action may be induced by light, also by electricity.

A mixture of equal volumes of H and Cl placed in the direct rays of the sun causes the chemical affinity between them to exert itself with explosion and the production of HCl, hydrochloric acid.

If a mixture of two volumes of H and one volume of O be placed in a strong glass tube containing two platinum electrodes which are connected with an induction coil, and a spark of electricity be passed through the mixture, the chemical attraction between them exerts itself with the formation of H_2O, water.

Describe the chemical process (a) when iron rusts, (b) when wood burns, (c) when silver is tarnished by coal gas.

(a) Oxygen in the presence of moisture oxidizes the iron with the formation of Fe_2O_3, ferric oxid.

(b) Wood, which is composed of C, H, and O, when burned produces CO_2 and H_2O, with a residue of some charcoal when not completely decomposed.

(c) A black coating of silver sulfid, Ag_2S, forms on silver exposed to coal gas, due to the presence in the coal gas of H_2S, hydrogen sulfid.

What is oxidation? Give an example.

Oxidation is the union of oxygen with other substances. *Example:* See preceding question, (a) and (b).

What is combustion? Give the chemical cause of spontaneous combustion.

Combustion is rapid oxidation with the evolution of heat and light.

Spontaneous combustion may be due to very active oxidation of certain substances in a very finely comminuted state, as occurs when finely divided phosphorus is exposed to the air or oxygen. It may be caused by direct chemical union, as occurs when pulverized antimony or arsenic are thrown into a vessel filled with dry chlorin gas. It may be due to hydration, as when lime combines with moisture, or to dehydration, as when strong sulfuric acid acts upon wood.

Describe two experiments showing the difference between mechanical and chemical action.

Mechanical Action.—Add sugar to water; it disappears as a solid, entering into solution and yielding to every particle of the water its characteristic sweetness; undergoing no chemical change, but a physical one.

Chemical Action.—Sugar treated with sulfuric acid undergoes chemical change and is converted into charcoal and water, forming a black liquid without the characteristic sweetness of sugar.

Mechanical Action.—Intimately mix 56 grains of iron filings and 32 grains of sulfur. The iron may be removed with a magnet or the sulfur dissolved with carbon disulfid.

Chemical Action.—Apply heat to the mixture of iron and sulfur, they enter into chemical union and form a new substance, FeS, iron sulfid, from which the iron cannot be removed with a magnet, nor the sulfur dissolved with carbon disulfid.

Give the difference between chemical dissociation and decomposition, with an example of each.

Dissociation is the separation of a compound into its ions when dissolved in a liquid or under the action of heat. When the conditions are changed, the ions reunite to form the original compound. *Examples:* Sodium chlorid dissolved in water partly separates into ions of sodium and chlorin, which reunite to form sodium chlorid on evaporation of the water. Ammonium chlorid heated to a high temperature separates into ions of ammonia, NH_3, and hydrochloric acid, HCl, which reunite to form ammonium chlorid, NH_4Cl, upon reduction of the temperature.

Decomposition is the separation of a compound into two or more dissimilar substances which do not reunite to form the original compound when the conditions are changed. *Example:* Calcium carbonate (marble), heated in the air, yields calcium oxid and carbon dioxid, as shown by the equation: $CaCO_3 = CaO + CO_2$.

Into what two principal groups are elements divided? Define positive and negative elements, giving examples of each.

Into metals (positive) and metalloids or non-metals (negative).

A *positive* element is one which is attracted to the negative pole of an electric battery when a compound is electrolyzed. *Example:* Hydrogen, sodium, gold.

A *negative* element is one which separates at the positive pole when an electric current is conducted through a compound. *Example:* Chlorin, oxygen, iodin.

Explain the difference between metals and non-metals.

Metals are solid substances at ordinary temperature (except mercury), opaque, with more or less metallic luster, malleable, ductile and tenacious. They conduct well both heat and electricity and are *electropositive*, capable of forming basic substances and salts. Those elements which do not possess most of these properties are classed as *non-metals*.

Mention the elements (a) existing uncombined in nature; (b) those which are gases, and (c) liquids, at ordinary temperature and pressure.

(a) Oxygen, hydrogen, sulfur, carbon, nitrogen, argon, helium, gold, silver, platinum, mercury, and copper.

(b) Oxygen, hydrogen, nitrogen, chlorin, fluorin, argon, helium, neon, xenon, and krypton.

(c) Mercury and bromin.

In composition with what elements are the following elements most commonly found in nature: (a) iron, (b) copper, (c) mercury, (d) sodium, (e) gold, (f) silver, (g) chlorin? Which occur free?

(a) Oxygen and sulfur; (b) oxygen, carbon and oxygen, sulfur, iron and sulfur; (c) sulfur; (d) chlorin; (e) tellurium, sulfur; (f) sulfur, chlorin; (g) sodium.

Those occurring free in nature are copper, mercury, gold, and silver.

Which metal is (a) the least tenacious, (b) the most infusible, (c) the best for electromagnets, (d) the best for electroconductors, (e) the most rare?

(a) Mercury; (b) osmium; (c) iron; (d) silver; (e) radium.

Which is the most abundant element? Name the elements represented by the following symbols: K, Na, Ni, Si, Sb, S, Mg, Pb, Cu, Hg, Ag, Co, Mn, F, P.

Oxygen is the most abundant element. K, potassium; Na, sodium; Ni, nickel; Si, silicon; Sb, stibium (antimony); S, sulfur; Mg, magnesium; Pb, plumbum (lead); Cu, copper; Hg, hydrargyrum (mercury); Ag, argentum (silver); Co, cobalt; Mn, manganese; F or Fl, fluorin; P phosphorus.

Mention six elementary substances commonly used in their pure state in medicine.

Oxygen, mercury, iodin, iron, phosphorus, sulfur.

Name the (a) alkaline (alkali) elements, indicate which are fixed and which volatile, and (b) the metals of the alkali earths.

(a) Potassium, sodium, lithium, are fixed alkalies. Ammonium radical, is volatile.

(b) Barium, strontium, calcium, magnesium.

Explain the term alkali and concisely state its properties.

Alkali is a substance having the strongest basic (*electropositive*) properties, usually referring to the oxids and hydroxids of the alkali metals and metals of the alkali earths. Such substances are very soluble in water; change red litmus to blue; unite with and neutralize acids, forming salts, and emulsify fats.

How does each of the following affect litmus paper: (a) H_2O, (b) H_2SO_4, (c) NH_4OH, (d) $NaHCO_3$?

(a) No effect. (b) Changes it to red; (c) and (d) turn it blue.

Give the names of two elements in each of the following groups: (a) Univalent, (b) bivalent, (c) trivalent, (d) quadrivalent.

(a) Hydrogen, chlorin; (b) oxygen, barium; (c) nitrogen, phosphorus; (d) carbon, platinum.

Define and give illustrations of allotropism (allotropy).

Allotropism ("a turn or change") the property possessed by certain elements of presenting themselves in two or more different forms, which may differ in their physiologic action. *Example:* The allotropic forms of carbon are: diamond, graphite, and charcoal; of phosphorus: yellow, white, red, and black. All the varieties of phosphorus are toxic except the red.

Name and define the laws governing chemical combination of elements. Give examples.

1. *Law of Constant or Definite Proportion.*—The same compound is always composed of the same elements in constant proportions by weight. *Example:* NaCl, sodium chlorid, is composed of 23 parts by weight of Na and 35.5 parts of Cl.

2. *Law of Multiple Proportions (Ratio).*—When two elements unite in several different proportions, the weight of one is constant and the weight of the other varies according to a simple multiple ratio.

Example:

		H	O	
H_2O	=	2	16	parts by weight.
H_2O_2	=	2	32	parts by weight.
		Hg	Cl	
HgCl	=	200	35.5	parts by weight.
$HgCl_2$	=	200	71	parts by weight.

3. *Law of Equivalent Proportions or Reciprocal Proportions.*—The weights of different elements which combine separately with one and the same weight of another element, are either the same or are simple multiples of the weights of these different elements which combine with each other. *Example*:

H, 1 part by weight, unites with Cl, 35.5 parts by weight.
H, 1 part by weight, unites with O, 8 parts by weight.

Then the proportions by weight in which Cl and O would unite would be as 35.5 is to 8.

4. *Law of Gaseous Volume (Gay Lussac's Law.)*—When chemical action takes place between gases, either elements or compounds, the volume of the gaseous product bears a simple relation to the volumes of the reacting gases. *Example:* H, 11.16 liters, unites with Cl, 11.16 liters, to form HCl, 22.32 liters.

Define (a) isomerism, (b) metamerism, (c) polymerism, and give an example of each.

(a) *Isomerism.*—Compounds which contain the same elements in the same relative proportions by weight in the molecule, but differ more or less widely in their physical, chemical, and physiologic properties, are called *isomeric*, *isomerids*, or *isomers*. *Example:* $C_{10}H_{16}$ is the molecular formula for oil of lemon, turpentine and a number of other oils.

(b) *Metamerism.*—Compounds having the same percentage composition and the same molecular formula are called *metameric*, *metamerids*, or *metamers*. *Example:* See example under isomerism.

(c) *Polymerism.*—Compounds possessing the same percentage compo-

sition, but different molecular formulas are termed *polymeric*, *polymerids*, or *polymers*. *Example:*

CH_2O,	Formaldehyde.
$C_2H_4O_2$,	Acetic acid.
$C_3H_6O_3$,	Lactic acid.
$C_6H_{12}O_6$,	Glucose.

Define and illustrate the terms: (a) acids, (b) bases, (c) salts.

(a) Acids are compounds having *electro-negative* or *anionic* properties and containing *hydrogen*, which is replaceable by metals to form salts. They change blue litmus to red. *Examples:* HCl, H_2SO_4.

(b) Bases are the oxids or hydroxids of metals, especially of the alkali and alkali earth metals, having *electropositive* or *cationic* properties. When in solution they neutralize acids, forming salts and water. They emulsify fats and change red litmus to blue.

(c) Salts are compounds composed of a positive element or radical united with a negative element or radical. They are formed in five ways:

1. By the union of a metal (+) and a non-metal (−).

$$Na+Cl=NaCl.$$

2. By the union of a basic oxid (+) and an acidic oxid (−).

$$CaO+CO_2=CaCO_3.$$

3. By the union of a base (+) or basic radical and an acid (−).

$$NaOH+HCl=NaCl+H_2O.$$
$$NH_3+HCl=NH_4Cl.$$

4. By the action of a metal on an acid.

$$Zn+H_2SO_4=ZnSO_4+H_2.$$

5. By the substitution of one radical for another.

$$NaCl+AgNO_3=NaNO_3+AgCl.$$

What is a (a) normal salt, (b) an acid salt, (c) a double salt? Give an example of each.

(a) A *normal* salt is one in which all the H of an acid is replaced by a metal or basic radical. *Example:* Na_2SO_4.

(b) An *acid* salt is one in which only part of the H of an acid is replaced by a metal or basic radical. *Example:* $NaHSO_4$, acid sodium sulfate (bisulfate); $NaHCO_3$, acid sodium carbonate (bicarbonate).

(c) A *double* salt is a combination of two salts. *Example:* $(KCl)_2PtCl_4$, potassioplatinic chlorid; $K_2SO_4Al_2(SO_4)_3$ potassio-aluminic sulfate (alum).

Differentiate between a simple salt and an oxysalt, giving an example of each.

A *simple salt* is produced by the union of a metal or basic radical with a negative element except oxygen; or it is the compound resulting from the replacement of the H in a hydrogen acid. *Example:* $NaCl$, NH_4I.

An *oxysalt* is a compound in which the H of an oxyacid has been partly or wholly replaced by a metal. *Example:* NaH_2PO_4, Na_2HPO_4, Na_3PO_4.

Give the chemical nomenclature of (a) salts and (b) acids, with examples.

(a) The positive element or radical of a salt is named first, and then the negative element, which terminates in "*id*" in simple salts and "*ite*" and "*ate*" in the case of oxysalts. *Examples:* $BaCl_2$, barium chlorid; Na_2SO_3, sodium sulfite; Na_2SO_4, sodium sulfate.

(b) In the case of hydrogen acids "*hydro*" is prefixed to the negative element, which terminates in "*ic*"; or the suffix "*hydric*" may be attached to the negative element. *Example:* HCl, hydrochloric or chlorohydric acid.

Oxyacids are named according to the acidic oxids (anhydrids) to which they correspond. *Example:* H_2SO_4, sulfuric acid, corresponds to SO_3, sulfuric oxid; H_2SO_3, sulfurous acid, corresponds to SO_2, sulfurous oxid.

Explain the significance of the prefixes: hydro, hypo, hyper, sub, bi, nitro, proto, sesqui; and the suffixes (affixes): ous, ic, ite, ate, and id.

Hydro indicates a compound containing hydrogen combined with another element, as hydrochloric acid.

Hypo is prefixed to a compound containing less of the negative element, oxygen, than the *ous* compound in that series, as hyposulfurous acid.

Hyper (*per*) indicates that the compound contains a greater amount of oxygen than the *ic* compound in the series, as hyperchloric oxid.

Sub designates a combination of two atoms of the positive element with one atom of the negative element, as Ag_2O, suboxid of silver; K_2S, potassium subsulfid.

Bi represents a combination of one atom of the positive element with two atoms of the negative element, as $HgCl_2$, mercury bichlorid.

Nitro indicates the presence of the NO_2 radical in a compound, as $C_3H_2\ (NO_2)_3\ (OH)_3$, trinitroglycerin.

Proto (*mono*) refers to a combination of one atom of the positive element with one atom of the negative element, as NaCl, sodium chlorid.

Sesqui is a combination of two atoms of the positive element with three atoms of the negative element, as Fe_2O_3, iron sesquioxid.

The suffix *ous* indicates that a compound contains less, and the suffix *ic* that it contains more, of the other or electronegative element, as HgCl, mercurous chlorid; $HgCl_2$, mercuric chlorid. A compound ending in "*ic*" is also the most stable compound in a series.

The suffixes *ite* and *ate* indicate an oxysalt; *ite* is used when the salt is produced from an oxyacid terminating in *ous;* and *ate*, when the acid terminates in *ic*, as Na_2SO_3, sodium sulfite. Na_2SO_4, sodium sulfate.

The term *id* indicates a simple salt, as KI, potassium iodid.

What are chlorids, bromids, and iodids? Give examples.

They are binary compounds, usually simple salts, composed of chlorin, bromin, or iodid with a metal or basic radical. *Examples:* NaCl, sodium chlorid; HCl, hydrogen chlorid.

Define and give an example of the terms: (a) Basic radical and (b) acidulous radical, (c) hydrid, (d) hydroxid (hydrate), (e) haloid salt, (f) binary compound, (g) anhydrid.

(a) A compound of two or more elements having positive properties and capable of acting like an element. *Example:* NH_3.

(b) A compound of two or more elements having negative properties and capable of acting like an element. *Example:* SO_4, NO_3, PO_4.

(c) A binary compound containing hydrogen. *Example:* LiH, lithium hydrid.

(d) A compound of hydroxyl (OH), combined with a metal or basic radical. *Example:* KOH, potassium hydroxid, NH_4OH.

(e) A salt containing the *halogen* elements, Fl, Cl, Br, and I. *Example:* NaCl.

(f) A *binary compound* is one which is composed of two elements. *Example:* $CaCl_2$.

(g) *Anhydrid* (acidic oxid) is an oxid capable of combining with the elements of water and forming an oxyacid. *Example:* N_2O_5, nitric anhydrid$+H_2O=2HNO_3$, nitric acid; KBr, potassium bromid; HBr, hydrogen bromid; KI potassium iodid; HI, hydrogen iodid.

Explain the difference between a sulfate and a sulfite, and give an example of each.

A *sulfate* is an oxysalt in which the hydrogen of sulfuric acid has been partly or wholly replaced by a metal or basic radical. The molecule of a sulfate contains the acidulous radical SO_4. *Examples:* $NaHSO_4$, sodium acid sulfate or bisulfate; Na_2SO_4, sodium sulfate.

A *sulfite* is an oxysalt in which the hydrogen of sulfurous acid has been partly or wholly replaced by a metal or basic radical. Its molecule contains the acidulous radical SO_3. *Examples:* $NaHSO_3$, sodium acid sulfite or bisulfite; Na_2SO_3, sodium sulfite.

What is the essential element of all acids? Differentiate between hydracids and oxyacids.

Hydrogen is the essential element. Hydracids (hydrogen acids) are compounds composed of hydrogen and a non-metallic element, except oxygen, as HCl, H_3As, hydro-arsenic acid.

Oxyacids are the hydrates of acidic oxids, ternary compounds containing hydrogen, oxygen, and another element, as H_2SO_4, from SO_3+H_2O.

Explain the terms (a) solution, (b) precipitate, (c) incompatible, (d) nascent state, (e) alloy, (f) amalgam.

(a) A liquid in which is dissolved a solid, liquid, or gaseous substance.

(b) A solid substance thrown out of solution by chemical action.

(c) Substances which, when brought together, result in a precipitate, or produce a poisonous, inflammable or explosive substance or otherwise modify their individual characteristic properties.

(d) *Nascent state* ("*nascere*," to be born) refers to the moment of liberation of an element or group of elements from its compounds.

(e) *Alloy* means a mixture of two or more metals, as Cu and Zn to form brass.

(f) An *amalgam* is an alloy containing mercury, as tin and mercury.

What is a chemical reagent?

A substance which, when brought in contact with another substance, produces some new substances, the chemical action manifesting itself by a coloration or the formation of a precipitate.

Define qualitative and quantitative analysis. Illustrate each.

Qualitative analysis determines the constituents of a body or a compound by forming with each constituent a compound of a different character. *Example:* A solution of silver nitrate treated with hydrochloric acid yields a white precipitate of silver chlorid. The ions of silver unite with the ions of chlorin and precipitate; the hydrogen ions and the nitric acid radical, NO_3, unite to form nitric acid which is held in solution; then more ionization occurs and the process is repeated.

Quantitative analysis determines the quantity of the constituents in a body or compound by various means. *Example:* The resulting precipitate of silver chlorid, obtained from a solution of silver nitrate treated with an excess of hydrochloric acid, washed, dried, and weighed and the quantity of silver present in the silver nitrate calculated from the weight of the silver chlorid.

What is the difference between analytic and synthetic methods in chemistry? Illustrate each.

Analytic methods split a compound into a simpler compound or its elements. *Example:* Heating HgO yields Hg+O.

Synthetic methods build up from simpler substances more complex bodies. *Examples:* Heating metallic copper in the air yields cupric oxid.

Give the flame test for barium, strontium, and calcium.

A clean platinum wire, moistened with hydrochloric acid and coated with the metal either in powder form or in solution, when held over a Bunsen burner, imparts to the flame a *yellowish-green* color in the case of barium; a *brilliant red* in the case of strontium, and a *yellowish-red* in the case of calcium.

Give a test for sulfuric acid in vinegar.

On addition of some barium chlorid solution to the vinegar a *white* precipitate of barium sulfate, insoluble in acids, indicates the presence of sulfuric acid.

In a solution containing calcium and magnesium how would you separate and distinguish the two metals?

The addition of NH_4Cl, NH_4OH and $(NH_4)_2CO_3$ precipitates the calcium, which imparts to the flame of a Bunsen burner a *yellowish-red* color. If the solution is filtered and the filtrate evaporated to a small volume, the addition of NH_4OH, and sodium hydrogen phosphate causes a white precipitate of *magnesium ammonium phosphate*, indicating the presence of magnesium.

Define a reaction and an equation.

A *reaction* is the chemical change which occurs when two or more substances are brought together.

An *equation* is the representation of the chemical change occurring in a reaction by means of symbols and formulas.

3

Complete the following equations and write the name of each resulting compound under its formula:

(a) $As_2O_3 + 3H_2S =$
$H_2SO_4 + NaNO_3 =$
$As_2O_3 + 3H_2S = As_2S_3 + 3H_2O.$
Arsenious sulfid. Water.

$H_2SO_4 + NaNO_3 = NaHSO_4 + HNO_3.$
Sodium hydrogen sulfate. Nitric acid.

(b) $HgSO_4 + Hg + 2NaCl =$
$FeSO_4 + 2NaHCO_3 =$
$HgSO_4 + Hg + 2NaCl = 2HgCl + Na_2SO_4.$
Calomel. Sodium sulfate.

$FeSO_4 + 2NaHCO_3 = FeCO_3 + Na_2SO_4 +$
Ferrous carbonate. Sodium sulfate.
$H_2O + CO_2.$
Water. Carbon dioxid.

(c) $C_2HCl_3O + NaOH =$
$Pb(NO_3)_2 + K_2CrO_4 =$
$C_2HCl_3O + NaOH = CHCl_3 + NaCHO_2.$
Chloral. Chloroform. Sodium formate.
(Note: KOH yields similar results.)
$Pb(NO_3)_2 + K_2CrO_4 = PbCrO_4 + 2KNO_3.$
Plumbic chromate. Potassium nitrate.

(d) $Ca(OH)_2 + CO_2 =$
$NaC_2H_3O_2 + NaOH =$
$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O.$
Calcium carbonate. Water.

$NaC_2H_3O_2 + NaOH = CH_4 + Na_2CO_3.$
Methane. Sodium carbonate.

(e) $2NaCl + Ag_2SO_4 =$
$BaO_2 + CO_2 + H_2O =$
$2NaCl + Ag_2SO_4 = 2AgCl + Na_2SO_4.$
Argentic chlorid. Sodium sulfate.

$BaO_2 + CO_2 + H_2O = BaCO_3 + H_2O_2.$
Barium carbonate. Hydrogen peroxid or dioxid.

(f) $C_2H_5Cl + AgOH =$
$Sb_2S_3 + 6HCl =$
$C_2H_5Cl + AgOH = AgCl + C_2H_5OH.$
Argentic chlorid. Alcohol (Ethyl).

$Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S.$
Antimony chlorid. Hydrogen sulfid.

(g) $2C_2H_3O.OK + H_2SO_4 =$
$2C_2H_3O.OK + H_2SO_4 = K_2SO_4 + 2HC_2H_3O_2$ or
Potassium acetate. Potassium sulfate. Acetic acid.
$2C_2H_3O.OH.$

(h) $2NaCl + H_2SO_4 =$
$CaCO_3 + 2HCl =$
$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl.$
Sodium sulfate. Hydrochloric acid.

$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2.$
Calcium chlorid. Water. Carbon dioxid.

(i) $MgCl_2 + NH_4Cl + Na_2HPO_4 =$
$C_2H_5OH + C_2H_5HSO_4 =$
$MgCl_2 + NH_4Cl + Na_2HPO_4 = MgNH_4PO_4 +$
Magnesium ammonium phosphate.
$2NaCl + HCl.$
Sodium chlorid. Hydrochloric acid.

$C_2H_5OH + C_2H_5HSO_4 = (C_2H_5)_2O + H_2SO_4.$
Alcohol. Ethyl hydrogen sulfate. Ether (Ethyl). Sulfuric acid.

(k) $CaCl_2 + Na_2CO_3 =$
$FeCl_3 + 3NH_4OH =$
$CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl.$
Calcium carbonate. Sodium chlorid.

$FeCl_3 + 3NH_4OH = Fe(OH)_3 + 3NH_4Cl.$
Ferric hydroxid. Ammonium chlorid.

(l) $C_2H_5OH + NaC_2H_3O_2 + H_2SO_4 =$
$CO(NH_2)_2$ or $CON_2H_4 + 2H_2O =$
$C_2H_5OH + NaC_2H_3O_2 + H_2SO_4 =$
$C_2H_5C_2H_3O_2 + NaHSO_4 + H_2O.$
Ethyl acetate. Sodium hydrogen sulfate. Water.

$CO(NH_2)_2$ or CON_2H_4 or $CH_4N_2O + 2H_2O = (NH_4)_2CO_3.$
Urea. Urea. Urea. Ammonium carbonate.

(m) $PCl_3 + 3H_2O =$
$CH_3COONa + NaOH =$
$PCl_3 + 3H_2O = H_3PO_3 + 3HCl.$
Phosphorous chlorid. Phosphorous acid. Hydrochloric acid.

$CH_3COONa + NaOH = CH_4 + Na_2CO_3.$
Sodium acetate. Methane. Sodium carbonate.

(n) $BaO_2 + H_2SO_4 =$
$BaO_2 + H_2SO_4 = BaSO_4 + H_2O_2.$
Barium sulfate. Hydrogen dioxid.

Complete the following chemical equations:

(1) $FeSO_4 + K_2CO_3 =$
(2) $Ca(OH)_2 + 2HgCl =$
(3) $Pb(NO_3)_2 + 2KI =$

(1) $FeSO_4 + K_2CO_3 = FeCO_3 + K_2SO_4.$
(2) $Ca(OH)_2 + 2HgCl = Hg_2O + CaCl_2 + H_2O.$
(3) $Pb(NO_3)_2 + 2KI = PbI_2 + 2KNO_3.$

Give an equation showing the reaction when NH_3 comes in contact with an acid.

$NH_3 + HCl = NH_4Cl.$

Write a chemical equation showing a double decomposition.

$AgNO_3 + HCl = AgCl + HNO_3$.

Give the equation for the production of ammonia from ammonium chlorid and calcium hydroxid.

$2NH_4Cl + Ca(OH)_2 = CaCl_2 + 2H_2O + 2NH_3$.

Give an equation showing a mode of preparation of CH_4.

$NaC_2H_3O_2 + NaOH = CH_4 + Na_2CO_3$.

What reaction takes place when chloral hydrate is mixed (heated) with an alkali? Illustrate by equation.

The production of chloroform, a formate of the alkali metal, and water.

$$\underset{\text{Chloral hydrate.}}{C_2HCl_3OH_2O} + KOH = \underset{\text{Chloroform.}}{CHCl_3} + \underset{\text{Potassium formate.}}{KCOOH} + \underset{\text{Water.}}{H_2O}.$$

Indicate by chemical signs and symbols the reactions which occur when (a) a phosphorus match is lighted in the air, (b) sodium is placed on the surface of water, (c) hydrochloric acid is poured on marble.

(a) (1) $P_4 + \text{air } (5O_2) = \underset{\text{Phosphoric oxid.}}{2P_2O_5}$.

The P_2O_5 thus produced coming in contact with the moisture of the air produces meta phosphoric acid, which unites with more moisture to form orthophosphoric acid, as shown by the equations:

(2) $2P_2O_5 + 2H_2O \text{ (in air)} = \underset{\text{Metaphosphoric acid.}}{4HPO_3}$.

(3) $4HPO_3 + 4H_2O \text{ (in air)} = \underset{\text{Orthophosphoric acid.}}{4H_3PO_4}$.

(b) $Na_2 + 2H_2O = 2NaOH + H_2$.

(c) $CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$.

Explain the reaction which occurs when the aqueous solutions of the two parts of a Seidlitz powder are mixed.

The tartaric acid and sodium bicarbonate present react upon each other, producing sodium hydrogen tartrate, water, and carbon dioxid, as shown by the following equation:

$$\underset{\text{Rochelle salt.}}{KNaC_4H_4O_6} + \underset{\text{Sodium bicarbonate.}}{NaHCO_3} + \underset{\text{Tartaric acid.}}{H_2C_4H_4O_6} =$$

$$KNaC_4H_4O_6 + \underset{\text{Sodium hydrogen tartrate.}}{NaHC_4H_4O_6} + CO_2.$$

Composition of Seidlitz powder: The blue paper contains Rochelle salt, 120 gr. (7.8 gm.), and sodium bicarbonate, 40 gr. (2.6 gm.). The white paper contains tartaric acid, 35 gr. (2.3 gm.).

Write a formula (equation) showing the action of sulfuric acid on sodium chlorid.

$$\underset{\text{Sodium chlorid.}}{2NaCl} + \underset{\text{Sulfuric acid.}}{H_2SO_4} = \underset{\text{Hydrochloric acid.}}{2HCl} + \underset{\text{Sodium sulfate.}}{Na_2SO_4}.$$

Write the equation of the reaction occurring when pure wood alcohol is burned.

CH_3OH + air (O) = CO_2 + $2H_2O$.
Wood alcohol. Carbon dioxid. Water.

Iodin is precipitated from sodium iodate by sodium bisulfite and sulfur dioxid; describe the reaction by the chemical equation.

$2NaIO_3$ + $4NaHSO_3$ + SO_2 = Na_2SO_4 $4NaHSO_4$ + I_2.
Sodium iodate. Sodium bisulfite. Sodium sulfate. Sodium bisulfate

Write the equations which show the reactions occurring when corrosive sublimate and potassium iodid in solution are brought together.

(a) $HgCl_2$ + $2KI$ = HgI_2 + $2KCl$.
Corrosive sublimate. Red mercuric iodid precipitate.

(b) HgI_2 + $2KI$ = $(KI)_2HgI_2$.
Potassiomercuric iodid (in solution).

Give the equations representing what occurs (a) when a mixture of carbon monoxid and carbon dioxid is shaken with a solution of caustic soda, (b) when carbon dioxid and lime-water are brought together.

(a) $CO + CO_2 + 2NaOH = Na_2CO_3 + H_2O + CO$.

The CO_2 combines with the caustic soda to form soluble sodium carbonate which is held in solution by the water present, the CO remaining unchanged.

(b) CO_2 + $Ca(OH)_2$ = $CaCO_3$ + H_2O.
Calcium carbonate (a white precipitate).

Give the equation of the reaction which takes place when sodium phosphate and a lithium salt are mixed.

Na_2HPO_4 + $Li_3C_6H_5O_7$ = Li_3PO_4 + $Na_2HC_6H_5O_7$.
Lithium citrate. Lithium phosphate (white precipitate).

Illustrate by equation what happens when zinc is treated with muriatic acid.

$Zn_2 + 2HCl = 2ZnCl_2 + 2H_2$.

A physician who wished to give a patient hypophosphites and also some salt of manganese mixed a solution of manganese sulfate with a solution of calcium hypophosphite. What happened and why?

A precipitate was produced because the manganese sulfate in the presence of the calcium hypophosphite produced insoluble calcium sulfate, according to the following equation.

$MnSO_4 + Ca(H_2PO_2)_2 = CaSO_4 + Mn(H_2PO_2)_2$.

Find the weight and the volume of hydrogen contained in 17 grams of NH_3.

Seventeen grams of NH_3 represents 14 gm. of N and 3 gm. of H. One gram of hydrogen under standard temperature and pressure occupies a volume of 11.16 liters, therefore, 3 gm. of hydrogen would measure 3×11.16 liters $= 33.48$ liters.

Write an equation representing the reaction for making barium sulfate from sodium sulfate. How many grams of sodium sulfate are required to yield 2.33 grams of barium sulfate by this process (atomic weight of barium, 137)?

$Na_2SO_4 + BaCl_2 = BaSO_4 + 2NaCl.$

142 grams yield 233.

To produce 233 gm. of barium sulfate there is required 142 gm. of sodium sulfate, therefore:

$$\underset{BaSO_4}{233} : \underset{BaSO_4}{2.33} :: \underset{Na_2SO_4}{142} : \underset{Na_2SO_4}{x \text{ or } 1.42.}$$

Answer: 1.42 grams of sodium sulfate are required.

Calculate the per cent. of each constituent present in sulfuric acid (atomic weight of sulfur, 32).

H_2SO_4 is the molecular composition of sulfuric acid, which represents 2 parts of hydrogen, 32 parts of sulfur and 64 (4×16) parts of oxygen by weight.

Therefore, the molecular weight of sulfuric acid would be $2+32+64=98$; hence, 100 parts (per cent.) would be found by the following calculations:

$$98 : 100 :: 2 : x = 2.04+ \text{ per cent. hydrogen.}$$
$$98 : 100 :: 32 : x = 32.65+ \text{ per cent. sulfur.}$$
$$98 : 100 :: 64 : x = 65.30+ \text{ per cent. oxygen.}$$

What is the percentage composition of $NaNO_3$?

Na = 23 parts by weight.
N = 14 parts by weight.
O_3 = 48 parts by weight.
85 molecular weight.

$$85 : 100 :: 23 : x = 27.05+ \text{ per cent. sodium.}$$
$$85 : 100 :: 14 : x = 16.47+ \text{ per cent. nitrogen.}$$
$$85 : 100 :: 48 : x = 56.47+ \text{ per cent. oxygen.}$$

The skeleton of a man weighs 24 pounds and contains 58 per cent. of calcium phosphate, $Ca_3(PO_4)_2$. Find the weight of phosphorus present (atomic weight of Ca, 40; of P, 31).

100 per cent. : 58 per cent. : : 24 lbs. : x or 13.92 lbs. of $Ca_3(PO_4)_2$ contained in the 24 lbs.

$$Ca_3(PO_4)_2 = \left.\begin{array}{l} Ca_3 \times 40 = 120 \\ P_2 \times 31 = 62 \\ O_8 \times 16 = 128 \end{array}\right\} 310 \text{ the molecular weight of}$$

$Ca_3(PO_4)_2$ contains 62 parts of phosphorus.

Therefore, 310 : 13.92 : : 62 : x or 2.784 lbs. of phosphorus, which is the answer.

HYDROGEN

Give (a) the symbol of hydrogen and (b) state the form in which it exists in nature; (c) give a short description of its physical and chemical properties.

(a) H.

(b) As H in volcanic and natural gases; H_2O, in which form it is present to the greatest extent in combination; in natural gas, as CH_4; and a constituent of all animal and vegetable structures.

(c) It is a colorless, odorless, tasteless gas; combustible, burning with a colorless flame, yielding the greatest heat of all combustible substances, not a supporter of combustion. The resulting compound of its combustion in air is water. It is only slightly soluble in water and is the lightest of all elements. It is *electropositive*, capable of combining with many elements, as with O to form H_2O and H_2O_2; with N to form NH_3; with the halogen elements to form hydrogen acids.

Name the (a) lightest of all known elements and (b) give its chemistry, (c) with a test to prove that it will not support combustion, and (d) name the combination in which it is most commonly found.

(a) Hydrogen.

(b) See (c) of question immediately preceding.

(c) A burning taper is extinguished when plunged into a jar of hydrogen, the mouth of the jar being downward, although the hydrogen burns as it passes from the jar into the air.

(d) Water.

Give two methods of obtaining hydrogen and write the equations of the reactions pertaining thereto.

1. Zinc treated with dilute sulfuric acid.

$$Zn_2 + 2H_2SO_4 + H_2O = 2ZnSO_4 + 2H_2 + H_2O.$$

2. An electric current passed through water slightly acidulated with sulfuric acid.

$$H_2O + H_2SO_4 + \text{electric current} = \text{ions of } H_2 + SO_4.$$

The SO_4 ions split into SO_3+O ions, the SO_3 ions unite with H_2O to form H_2SO_4, this H_2SO_4 again passing through the same cycle.

Describe the method of preparing H by the action of Na on H_2O. Write the formula for the equation representing the reaction and find how many grams of H, 82 grams of Na would liberate by this process (atomic weight of Na, 23; H, 1; O, 16).

Plunge small pieces of Na, which has been freed from naphtha and cleaned, well wrapped with fine wire gauze into an inverted glass jar filled with water. The water immediately undergoes decomposition with the production of H, which collects at the top of the jar, and NaOH, which is held in solution in the water.

$$\begin{array}{ccccccc} Na & + & H_2O & = & NaOH & + & H. \\ 23 & + & 18 & = & 40 & + & 1 \text{ parts in grams.} \end{array}$$

Therefore, 23 grams of Na = 1 gram H; consequently, 82 gm. of Na = 3.565+ gm. H, as shown by the calculation 23 : 82 : : 1 : x = 3.565+.

How much water would be required to yield 100 grams; also 253 cc. of hydrogen? Exhibit calculations.

H_2O.

2+16=18, molecular weight. Then 18 grams H_2O will yield 2 gm. or 22,320 cc. of H.

2 : 100 : : 18 : x = 900 gm. of H_2O required for 100 gm. H.

22,320 cc. : 253 cc. : : 18 : x = 0.204 + gm. of H_2O required for 253 cc. H.

What are the chemical names of the following compounds of hydrogen and give their formula: (a) H and Br; (b) H and I; (c) H and S; (d) H and P; (e) H and As?

(a) Hydrobromic acid, HBr; (b) hydriodic acid, HI; (c) hydrosulfuric acid (hydrogen sulfid), H_2S; (d) hydrophosphoric acid (hydrogen phosphid), H_3P; (e) hydro-arsenic acid (hydrogen arsenid or arsenuretted hydrogen), H_3As.

WATER

Give the composition of water (a) by volume, (b) by weight, and (c) give its molecular weight.

(a) Two volumes (22,320 cc.) of H with one volume (11,160 cc.) of O.
(b) Two parts (as 2 gm.) of H with sixteen parts (as 16 gm.) of O.
(c) 18.

Determine the composition of water by (a) analysis, (b) synthesis.

(a) When water, slightly acidulated with sulfuric acid, is placed in a special form of apparatus having two tubes, and a current of electricity is passed through the mixture, the water is decomposed into two volumes of H for every one volume of O which collects in the separate tubes.

(b) Hydrogen passed over copper oxid in a hard glass tube heated to redness, combines with the oxygen of the copper oxid to form water, which may be collected in a suitable weighed vessel and weighed. The increase of weight of the vessel represents the weight of water produced and is the sum of the hydrogen employed and the weight of the oxygen given off by the copper oxid.

How may water be decomposed?

1. See preceding answer, (a).

2. By passing water vapor (steam) through an iron pipe heated to redness. Hydrogen is set free and passes out at the distal end of the pipe, the oxygen uniting with the iron and forming a coating of iron oxid on the pipe.

What is water chemically considered?

It is the *monoxid of hydrogen*, and is neutral in reaction. It may act as an electropositive or basic substance, as when it combines with acidic oxids

to form oxyacids, such as $SO_3+H_2O=H_2SO_4$. It may act as an electronegative or acidulous substance, as in its union with basic oxids, such as $K_2O+H_2O=2KOH$.

What is meant by a (a) hard water, (b) a soft water, and (c) how may a hard water be rendered soft?

(a) Water holding in solution mineral salts other than alkalies; it decomposes soap, yielding an insoluble precipitate, and does not readily produce a lather.

(b) Water holding in solution very little or no mineral salts, readily producing a lather with soap, with very little or no decomposition.

(c) When the hardness is due to calcium bicarbonate or other bicarbonates, boiling causes a splitting of the bicarbonates into insoluble carbonate, water and carbon dioxid, which passes off into the air, thereby rendering the water soft.

By distillation or the addition of an alkali or lime-water, the latter in not too large a quantity, water may be rendered soft.

Define hardness as applied to potable water and give its influence upon the physiologic processes.

See preceding question, (a).

Water containing more than a certain quantity of mineral salts when employed in the preparation of albumin-containing foods, as meats, eggs, etc., renders the albumin less digestible by causing the formation of hard masses of albumin combined with the metals.

When the hardness is due to bicarbonates, the latter neutralize the hydrochloric acid of the stomach, thereby interfering with the action of pepsin in gastric digestion.

Hard water often produces intestinal derangement in persons not accustomed to its use, and is believed by some to favor the formation of urinary and other calculi.

What are mineral waters?

Waters holding in solution more than a certain proportion of mineral salts, which render the water more or less unwholesome and nonpotable. They may possess various medicinal properties according to the character of the contained salts.

State the characteristics of the following mineral waters: (a) chalybeate; (b) bitter; (c) sulfur; (d) effervescent; (e) cathartic; (f) saline; (g) alkaline. Give examples of each.

(a) Waters containing *iron* in the form of sulfate, carbonate, and oxid, held in solution by the dissolved carbon dioxid, with some sodium, magnesium, and aluminium compounds. They have slight tonic virtues, but may, owing to their irritant action, cause gastric and intestinal derangement. *Examples:* Cresson Spring and Rockbridge water.

(b) Waters having a bitter taste due to *Epsom* or *Glauber's* salt in solution. They have a *cathartic* or *laxative* property. *Examples:* Epsom spring water, ($MgSO_4$); Hunyadi, (Na_2SO_4).

(c) *Sulfur waters* contain in solution alkalin sulfids or polysulfids, with

other salts, or hydrogen sulfid. They have *alterative* and slightly laxative properties, and are used mostly in the form of baths in the treatment of skin diseases, gout, and rheumatism. *Examples:* White Sulfur Springs and Blue Lick Springs.

(d) *Effervescent* (*carbonated*) *waters* are strongly charged with CO_2 gas and some carbonic acid. When exposed to lessened pressure the CO_2 gas is given off with effervescence. They have *sedative* and *slightly stimulating* properties and are especially useful in allaying vomiting. *Examples:* Apollinaris, Saratoga waters.

(e) Waters containing *cathartic* or *laxative* salts in solution, and, therefore, having cathartic or laxative properties; they also promote elimination by the kidneys and skin. *Examples:* Carlsbad, Hunyadi waters.

(f) Waters containing carbonates, sulfates, chlorids of sodium, potassium, lithium, magnesium, and calcium. Their properties are dependent upon the largest salt content, usually *laxative. Examples:* Kissingen, Saratoga waters.

(g) Waters containing a large quantity of sodium carbonate, with a certain proportion of chlorids, sulfates, and carbonates of other metals, as well as chlorid and sulfate of sodium. Their slightly *alkaline* property renders them useful in the rheumatic and gouty diatheses. *Examples:* Vichy, Buffalo Lithia waters.

To what salts do most cathartic mineral waters owe their virtues?

To magnesium sulfate or to sodium sulfate.

Give the general characteristics of (a) rain=water, (b) well=water, (c) river=water, (d) lake=water.

(a) *Rain water* is soft, *i. e.*, it contains very little or no mineral salts. It is excellent for the laundry, but less suitable for domestic purposes, generally, than pure ground or surface-water. The latter part of a rainfall is purer than the first part, as many impurities are washed out of the air. Rain water may contain traces of ammonia, nitric acid, salts, soot, dust, organic matter, and bacteria. Rain-water from roofs and that which is collected in large cisterns is unfit for drinking purposes, as the contained organic matter undergoes rapid putrefaction.

(b) *Well-water* is filtered rain-water, having passed through more or less earth, and contains mineral salts. It is usually wholesome, but may be rendered unpalatable by the contained mineral matter. The wholesomeness of well-waters depends on the depth of the well, the character of soil and underlying strata, and the presence or absence of decaying organic matter in the area drained.

(c) *River-water* may undergo sudden and great changes in character, due to contamination by sewage and waste, with its contained bacteria, from towns, cities, and manufacturing plants along the banks of the river and its tributaries.

(d) *Lake-water* is of quite constant composition and is wholesome, unless the lake is in close proximity to a settlement. Vegetable contamination is more marked in small lakes and ponds than in larger bodies of water, such as the Great Lakes of North America.

Describe (a) distillation, (b) filtration, and (c) precipitation, as applied to processes for purifying drinking water.

(a) *Distillation* removes all solids and deleterious substances and affords one of the best means at the command of the householder for purifying water. To render the water more palatable it should be shaken with air, or allowed to pass several times through several feet of air, from one vessel into another. This method of purification is not applicable to a municipal water-supply.

(b) *Filtration.*—By the ordinary household filter, water is freed from suspended matter and some bacteria are removed, but unless the filter is kept clean it soon becomes a bacteria breeder. The most modern method of clarifying water for cities by passing it through a filter-bed several feet in thickness, composed of stone, gravel, and sand, not only removes suspended matter, but many bacteria and other organic matter, which is oxidized and rendered harmless by the action of the bacterial jelly formed on the surface of the sand.

(c) *Precipitation.*—The simplest method of purifying water by precipitation consists in adding 1 to 2 gr. of alum to each gallon of water. The carbonates in the water decompose the alum, forming a white, flocculent, jelly-like magma of aluminum hydroxid which entangles suspended matter, bacteria, and unites with soluble coloring matter, causing their precipitation.

What does the presence of an abnormal quantity of chlorin in drinking water indicate?

Chlorin may indicate *sewage* contamination or *salt*, due to the passage of the water through salt beds or to the proximity of the ocean. The spray from the sea is capable of affecting the chlorin content of waters at a distance of fifty miles inland.

Describe two tests for organic matter in water.

1. Evaporating a volume of 100 cc. to 200 cc. of water to dryness and heating the residue of organic matter: a brown to black color is produced.

2. Place in separate flasks 100 and 500 cc. of the water with a few drops of pure sulfuric acid and 10 cc. of a weak solution of potassium permanganate, and the same quantity of distilled water in separate flasks treated in the same manner; cork the flasks and allow them to stand. At the end of 15 minutes, 30 minutes, and 1 hour compare the color of the water under examination with the distilled water; any lessening of coloration, or change to brown, indicates the presence of organic matter.

Explain how water containing organic impurities may become purified by running in a shallow stream over a precipice.

The water in passing over a precipice presents a large surface to the oxygen in the air, which oxidizes the organic matter and renders it harmless.

Give two chemical tests for water supposed to be contaminated with sewage.

1. Determine the quantity of chlorids present by means of a standard solution of silver nitrate, using potassium chromate as an indicator. An excess of chlorids indicates sewage (see second question on this page).

2. Distil the water until it is free from ammonia, then add to the remainder an alkaline solution of potassium permanganate, and again distil. Collect the second distillate in a Nessler tube and treat with Nessler's solution; a yellow to brown color or a brown precipitate indicates organic matter (sewage).

Mention the objection to lead water-pipes. State the kind of water which, when used with these pipes, is especially dangerous.

Lead is poisonous and water passing through lead pipes dissolves some of the lead. The use of such water for drinking purposes may cause plumbism. Soft, pure water and rain-water passing through lead pipes have considerable solvent action upon lead, and such water is, therefore, very dangerous. Water containing bicarbonates, in passing through lead pipes, produces lead carbonate, which forms a white coating on the lead pipe and prevents solution of the lead in the water.

Describe a method for detecting lead in water.

Add to the water in a tall glass cylinder (about 2 feet high) a drop or two of ammonium sulfid: a brown-black coloration or precipitate shows the presence of lead. The color or precipitate is not cleared up with hydrochloric acid (distinction from iron) nor by potassium cyanid (distinction from copper).

How much water vapor will be formed by the union of 500 cubic centimeters of hydrogen and 250 cubic centimeters of oxygen?

At standard temperature and pressure 500 cc. (22,320 cc. water is composed of 22,320 cc. of H and 11,160 cc. of O).

When potassium is thrown on water, what is the name and formula of the resulting compound?

Potassium hydroxid, KOH.

HYDROGEN DIOXID

Describe hydrogen dioxid, and give a method of preparation with the equation pertaining thereto.

Hydrogen dioxid (peroxid), when pure, is a colorless liquid having an odor similar to that of a weak solution of chlorin, a metallic taste, and a syrupy consistence. It is soluble in water, alcohol, and ether in all proportions. As found in commerce it is usually an aqueous solution containing 3 per cent. of hydrogen dioxid, or a 10 to 14 volume solution. It readily decomposes into water and oxygen at ordinary temperatures, more rapidly at higher temperatures.

Preparation.—Phosphoric acid acting on barium dioxid suspended in water.

$$BaO_2 + H_3PO_4 + H_2O = BaHPO_4 + H_2O_2 + H_2O.$$

The hydrogen dioxid is held in solution in the water, which is withdrawn from the mixture and evaporated in a vacuum over sulfuric acid to the desired consistency.

Give the formula of hydrogen dioxid and name its uses in medicine.

H_2O_2. *Antiseptic*, *deodorant*, and *styptic;* hence serviceable as a topic application to the throat in diphtheria and scarlatina or as a disinfectant lotion for wounds and abscesses. It may be administered internally as an *antidote* to cyanids, phosphorus, and alkaloids. It may be employed as a *bleaching agent* for the bleaching of teeth and hair.

What is a fourteen-volume solution of hydrogen dioxid?

A fourteen-volume solution is one which will yield 14 volumes (14 cc.) of oxygen from one volume (1 cc.) of hydrogen dioxid, under the most favorable conditions.

To what are the bleaching and antiseptic properties of hydrogen dioxid due?

To the production of nascent oxygen from the hydrogen dioxid.

Give two tests for hydrogen dioxid.

1. Hydrogen dioxid added to a solution containing starch and potassium iodid liberates the iodin, which unites with the starch, producing a *blue* color.

2. A solution of potassium dichromate, acidulated with dilute sulfuric acid and treated with hydrogen dioxid, yields *blue perchromic acid.*

OXYGEN

Describe oxygen as to (a) occurrence, (b) physical properties, (c) chemical properties, and (d) give two methods of obtaining it.

(a) Oxygen is the most abundant element in nature, occurring free in the air, of which it forms about $\frac{1}{5}$ part by volume. It is found widely distributed in chemical combination as water, of which it forms $\frac{8}{9}$ part by weight, as oxids, oxyacids, oxysalts, and in almost all animal and vegetable compounds.

(b) It is a colorless, odorless, and tasteless gas, the supporter of combustion, but noncombustible, soluble to the extent of about 3 per cent. in water at ordinary temperatures. It may be liquefied and solidified under certain conditions of temperature and pressure.

(c) It is the most powerful *electronegative* (anionic) element, capable of uniting with all elements except fluorin, bromin, and the helium group.

(d) 1. Barium monoxid, when heated in the air, takes up an atom of oxygen, forming barium dioxid, which, when heated in a vessel from which the air is excluded, yields one atom of oxygen for each molecule of barium dioxid.

$$BaO + O = BaO_2.$$
$$BaO_2 \text{ heated} = BaO + O.$$

2. By heating potassium chlorate alone or mixed with manganese dioxid, to prevent too rapid decomposition and avoid explosion.

$$KClO_3 \text{ in air } (O) = KClO_4.$$
$$\text{The } KClO_4 \text{ under heat} = KCl + O_4.$$
$$\text{or } 2KClO_3 \text{ heated} = KCl + 3O_2.$$

Give the atomic and molecular weight, the atomic and molecular volume, and the density of oxygen.

Atomic weight, 16; molecular weight, 32; atomic volume, 1 (11.16 liters); molecular volume, 2 (22.32 liters); density (specific gravity) compared with H, as 1, = 16; density (specific gravity) compared with air, 1.1056.

Give a brief description of three experiments illustrating the properties of oxygen.

1. A piece of smouldering charcoal placed in a jar of oxygen bursts into flame, burning vividly.

2. A small piece of dry phosphorus warmed in a deflagrating spoon and plunged into oxygen burns with a brilliancy painful to the eye.

3. A steel watch-spring tipped at one end with burning sulfur, when placed in oxygen, burns with intense light and emits sparks.

What element composes over half the matter of the earth and is the common supporter of combustion?

Oxygen.

Describe the medicinal uses of oxygen, stating how it is brought to the bedside and how it is applied.

Oxygen is used largely in respiratory or circulatory affections with deficient oxygenation of the blood, as pneumonia. It is also used for dangerous chloroform narcosis and poisoning by coal-gas and other noxious vapors.

The gas is brought to the bedside in steel cylinders in the liquid state and allowed to escape slowly from the cylinder into a rubber bag until the latter is filled; it is then slowly conducted through a wash bottle containing water, and inhaled by the patient through a suitable mouth or nose-piece.

Describe the relation of oxygen to combustion and to life, giving the method by which it is carried to the various parts of the body.

It is absolutely necessary to both. Combustion is rapid oxidation; it is indispensable to the animal for the oxidative changes occurring in metabolism. It is taken into the lungs by inspiration and unites with the hemoglobin of the blood, forming oxyhemoglobin, in which form it is carried to the various tissues of the body by the arterial system. The oxyhemoglobin splits up into oxygen and hemoglobin as it passes from the arterioles into the venules.

OZONE

Name and describe an allotropic form of oxygen, giving its symbol.

Ozone, symbol O_3, a colorless gas having an odor resembling that of chlorin, irritating to mucous membranes and rapidly producing headache. It is a powerful oxidizing agent, rapidly destroying organic matter and oxidizing metals; it bleaches vegetable coloring matter. It is liquefiable and forms an intensely blue liquid.

Give a (a) method of preparing ozone and (b) show how it may be detected in the air.

(a) A hot glass rod held in the vapors of ether yields ozone.

(b) Moistened iodized starch paper suspended in air containing ozone burns blue, due to the liberation of the iodin by the action of the ozone, forming *blue iodid of starch.*

Compare ozone with oxygen as to (a) occurrence, (b) properties.

(a) Ozone is found in the air in extremely small quantities, especially in the atmosphere of cities; it is more abundant in the air of pine forests than elsewhere, due to the oxidation of the turpentine. Oxygen is present in all atmospheric air to the extent of 21 per cent. by volume.

(b) Ozone is a most powerful oxidizing agent, attacking metals like mercury upon which ordinary oxygen fails to act, and supports combustion more vigorously than oxygen. Ozone will not support life. It acts on the respiratory mucous membranes as an irritant, whereas oxygen is the supporter of respiration.

NITROGEN

Give (a) the symbol, (b) atomic weight, (c) molecular weight, and (d) describe the properties of nitrogen (azote).

(a) N. (b) 14. (c) 28.

(d) A colorless, odorless, tasteless gas, neither combustible nor a supporter of combustion, and slightly lighter than air. Nitrogen is chemically inert, having little affinity for other elements except magnesium and a few others. Its compounds are unstable, often decomposing with explosive violence, as nitroglycerin. It is not poisonous, but animals cannot live in the pure gas because of the absence of oxygen, which is required for respiration.

Give (a) the occurrence of nitrogen and (b) state its importance in the free state, in combination (c) in inorganic, and (d) in organic compounds.

(a) It occurs free and as ammonia in the air; as nitrates and ammonium salts in the earth and in many vegetables (alkaloids), and animal compounds (proteins).

(b) It acts as a diluent of the inspired air to prevent too rapid oxidation of the tissues and is necessary to the life of certain lower orders of fungi.

(c) It forms very active compounds, as ammonia, nitrates, and oxids.

(d) It forms with C, H, and O highly explosive compounds, as guncotton and nitroglycerin; extremely poisonous compounds, as hydrocyanic acid and alkaloids; and substances of great nutritive value, as proteids.

Give two methods of obtaining nitrogen and state how it may be distinguished from hydrogen.

1. Burn phosphorus in a bell jar inverted over water. The oxygen unites with the phosphorus to form P_2O_5, which unites with the water to form H_3PO_4, leaving the nitrogen.

2. Heat a mixture of ammonium chlorid and potassium nitrite in a large volume of water. Equation:

$$NH_4Cl + KNO_2 = KCl + 2H_2O + N_2.$$

Nitrogen is noncombustible, while hydrogen burns readily. If each is mixed with oxygen and an electric spark passed, hydrogen forms water; nitrogen does not.

Give the formulas and names of the oxids (anhydrids) of nitrogen, indicating which are acid-forming oxids.

N_2O, hyponitrous oxid (nitrous oxid, monoxid, laughing-gas). Acid former.

N_2O_2, nitrogen dioxid (nitric oxid).

N_2O_3, *nitrous oxid* (nitrogen trioxid). Acid former = HNO_2.

N_2O_4, nitrogen tetroxid (nitrogen peroxid).

N_2O_5, nitric oxid (nitrogen pentoxid). Acid former = HNO_3.

HYPONITROUS OXID (LAUGHING-GAS)

Give the chemical name and formula of laughing-gas.

See preceding question.

Describe the preparation of nitrous oxid (laughing-gas), writing the equation of the reaction occurring. State the properties and uses of nitrous oxid.

By heating ammonium nitrate to 250° C. in a retort, water and nitrous oxid are produced. To purify the gas it is passed through a solution of ferrous sulfate to absorb any nitric oxid, and then through a solution of sodium hydroxid to remove any hydrochloric acid that may have been derived from the presence of ammonium chlorid. The gas should be collected over hot water, as it is soluble in cold water. Equation:

$$NH_4NO_3 \text{ heated } = 2H_2O + N_2O.$$

It is a colorless, odorless gas, having a sweetish taste; not combustible, but a supporter of combustion. It is used as an *anesthetic* in minor operations, as in the extraction of teeth and the divulsion of the anal sphincter, and is regarded as the safest anesthetic.

What is the difference between nitric oxid (NO) and air?

Nitric oxid is a colorless gas, becoming brownish-red when brought in contact with air or oxygen. It does not support combustion nor respiration. It has a definite percentage composition.

Air is a mechanical mixture of nitrogen, oxygen, and other gases (see page 50). It supports combustion and respiration.

NITRIC ACID

Give the names and formulas of the nitrogen acids.

Nitrous acid, HNO_2. Nitric acid, HNO_3.

Describe the process for the preparation of nitric acid with equation; its properties, and chemical and medical uses.

Heating a native nitrate, as sodium or potassium nitrate, in a retort with sulfuric acid. The nitric acid distils over and is collected in a receiver.

$$2NaNO_3 + H_2SO_4 = Na_2SO_4 + 2HNO_3.$$
$$2KNO_3 + H_2SO_4 = K_2SO_4 + 2HNO_3.$$

Pure nitric acid is a colorless, fuming, suffocating, and very corrosive liquid; specific gravity 1.52. The commercial article is yellow and of two varieties: *single aqua fortis*, specific gravity 1.25, containing 39 per cent. HNO_3, and *double aqua fortis*, specific gravity 1.4, containing 68 per cent. HNO_3.

It is *used* as a solvent for most metals, for etching metals, and for cleansing preparatory to lacquering and gilding, and is extensively employed in the preparation of many important organic compounds, as gun-cotton, nitroglycerin, picric acid, and celluloid.

In medicine it is used as a *caustic*, and as a *test for biliary coloring matter* and for *albumin* in the urine.

How is nitric acid distinguished from the other mineral acids?

Nitric acid with metallic copper yields a greenish-blue liquid and brownish-red fumes of N_2O_4. Other mineral acids under the same conditions do not cause these changes.

Differentiate between nitrates and nitrites. Mention two compounds of each that are commonly used in medicine.

A *nitrate* is an oxysalt derived from the displacement of the hydrogen of nitric acid by means of a metal, and contains the NO_3, acidulous radical. *Examples:* Sodium nitrate and potassium nitrate.

A *nitrite* is an oxysalt in which the hydrogen of nitrous acid has been replaced by a metal, and contains the NO_2, acidulous radical. *Examples:* Potassium nitrite and amyl nitrite.

AMMONIA

What is ammonia? Give the sources and uses of ammonia in medicine and in the arts.

Ammonia (NH_3) is a colorless gas having a characteristic pungent, suffocating odor, with strong alkaline properties. It is a volatile alkali. It is obtained chiefly from the ammoniacal liquors formed in the process of manufacturing illuminating gas. It may be obtained from its salts and certain nitrogenous organic compounds when heated with an alkali.

It is used in medicine as a rapidly acting *cardiac* and *general stimulant*.

In the arts it is used as a volatile base, antacid, and as a general cleansing agent in the household in the form of the water of ammonia (hartshorn).

Give the composition and method of preparation of aqua ammoniae.

Aqua ammoniæ (ammonium hydroxid, hartshorn) is composed of one molecule of ammonia, NH_3, in chemical union with one molecule of water.

$NH_3+H_2O=NH_4OH$. The NH_3 is supposed to unite with one of the H atoms of water to form the radical NH_4, which combines with the OH, hydroxyl group. It is prepared by heating ammonium chlorid with an alkali, as KOH, NaOH, or $Ca(OH)_2$ calcium hydroxid, the NH_3 gas being conducted into water kept at the temperature of the air.

What is ammonium?

Ammonium (NH_4) is the hypothetic electropositive base formed when ammoniacal gas combines with acids, as $2NH_3+H_2SO_4=(NH_4)_2SO_4$.

Give the composition, mode of preparation, properties, and medicinal uses of sal ammoniac (ammonium chlorid).

Its composition is NH_4Cl.

It may be prepared by neutralizing HCl with NH_3 gas or NH_4OH, the solution partially evaporated, and crystallization permitted to take place.

It is a colorless, odorless, crystalline, soluble substance having a salty taste and a neutral reaction. In medicine it is used as a *stimulating expectorant* and *alterative*.

Give the preparation, formula, characteristics, and medicinal uses of ammonium bromid.

Carefully pour one pound of bromin into four times its weight of distilled water in a stone jar, and gradually add one quart of ammonium hydroxid; cover the jar with a glass plate until the odor of bromin disappears. Evaporate the solution until crystallization of the ammonium bromid takes place. *Formula:* NH_4Br.

It is a colorless, odorless, prismatic crystalline salt, soluble in water, having a pungent, saline taste.

An aqueous solution, when treated with chlorin water, liberates the bromin, which may be dissolved with chloroform or carbon disulfid and gives a yellow to red-brown color. Medicinally it is a *sedative* and *depressant* to the motor and sensory functions of the spinal cord, its chief use being to allay nervous irritability and induce sleep.

AIR

Name the constituents of the atmosphere. Give the composition of air by weight and by volume.

	Weight.	Volume.
Nitrogen	76 per cent.	77 per cent., about.
Oxygen	23 per cent.	21 per cent.
Water vapor	Variable.	
Carbon dioxid		0.03 per cent.
Argon, Helium, Neon, Xenon, Krypton } Helium group		0.937 per cent.

Ammonia, Ozone, Nitric acid, Sulfurous oxid, Hydrogen sulfid (in towns). } traces.

What element constitutes four-fifths of the air?

Nitrogen.

What percentage of CO_2 exists normally in the atmosphere? What percentage of CO_2 is dangerous to life?

0.03 per cent. by volume.

Air containing 0.1 per cent. of CO_2 derived from the impurities of animal respiration is vitiated and dangerous to life. From 10 to 15 per cent. of

CO_2 derived from sources other than animal respiration renders the air poisonous, but not immediately fatal.

Demonstrate the fact that air is a mixture, not a chemical compound.

Air passed through boiled water loses about 3 per cent. of oxygen and less than 1 per cent. of nitrogen. By repeating the process all the oxygen may be extracted from the air, leaving much of the nitrogen. If the percentage proportion of nitrogen and oxygen in air be compared with the percentage found in each of the oxids of nitrogen, it will be found entirely different.

From what sources does the atmosphere become vitiated and unfit for respiration?

From the respiration of animals, which contains CO_2 and ptomains; from the production of CO_2 in nature and artificially, and CO in the manufacture of illuminating gas or incomplete combustion of carbonaceous substances; from the putrefaction of organic substances yielding noxious gases, and all processes which yield toxic gases.

How is the air of an apartment tested to determine the presence and amount of carbon dioxid in it?

By exposing a measured volume of the air to a definite volume of lime-water of a previously determined alkaline strength, by means of a decinormal oxalic acid solution. When all the carbon dioxid has combined with the lime-water, the alkalinity of the solution is again determined by means of the oxalic acid solution. The difference between the alkalinity before and after the addition of the air indicates the quantity of lime-water necessary to remove the carbon dioxid present in the volume of air acted upon, from which the amount of carbon dioxid is calculated.

CARBON

Give (a) the symbol, (b) specific gravity, and (c) the physical and chemical properties of carbon.

(a) C. (b) 3.5, compared with water, when in the form of the diamond, and 2.25 as graphite.

(c) Carbon is a solid, always black except in the form of the diamond, devoid of taste and odor, insoluble in all known liquids, and combustible, yielding CO_2. It is the transitional element which unites the three natural kingdoms. It enters into combination with many elements, producing very important compounds, as CN, HCN, CO, CH_4.

Describe the various allotropic forms of carbon.

Diamond, *graphite*, *charcoal* (coal, coke, animal and vegetable charcoal, lamp-black).

Diamond is the purest form of carbon; crystalline (either in cubes or octahedra), the hardest substance known, and possessing the greatest refractive power. It is a nonconductor of electricity and a poor conductor of heat. It burns at a high temperature, forming carbon dioxid.

Graphite (plumbago, black lead) is a bluish-black, almost infusible substance, with a metallic luster, having a greasy feel, and leaving a dark line when drawn across paper.

Charcoal is the product of incomplete combustion of carbonaceous substances. It occurs in a number of varieties and is used for various purposes.

What are the products of the combustion of ordinary coal?

Carbon monoxid and dioxid, with some sulfurous oxid and hydrogen sulfid.

What is the principal atom having linking functions?

Carbon.

CARBON MONOXID AND CARBON DIOXID

Give the name, formula, and properties of the two oxids of carbon, explaining the effect of each on animal life.

Carbon monoxid, CO, a colorless, odorless, and tasteless gas; lighter than air and burning with a blue flame, forming carbon dioxid. It acts as a direct poison to animals, entering into combination with the hemoglobin of the blood by displacing the oxygen to form carbon monoxid hemoglobin, which is a more stable compound than oxyhemoglobin, thereby depriving the hemoglobin of its oxygen-carrying power.

Carbon dioxid, CO_2, is a colorless gas having a slightly acid taste. It is heavier than air, soluble in water, upon which it confers increased solvent power. It is neither combustible nor a supporter of combustion. Pure carbon dioxid causes instant suffocation by "spasm of the glottis."

Give two methods of preparation for each of the oxids of carbon.

1. Carbon monoxid may be prepared by passing steam over red-hot coal, as in the making of *water-gas*.

$$C + H_2O = CO + H_2.$$

2. By heating oxalic acid with sulfuric acid,

$$H_2C_2O_4 + H_2SO_4 = H_2O + CO + CO_2 + H_2SO_4.$$

The gaseous mixture is passed through sodium hydroxid solution to remove the CO_2.

1. Carbon dioxid may be obtained by burning charcoal in air.

$$C + O_2 \text{ (air)} = CO_2.$$

2. By acting upon calcium carbonate with sulfuric acid.

$$CaCO_3 + H_2SO_4 = CaSO_4 + H_2O + CO_2.$$

What effect does carbon dioxid produce on lime-water?

It produces a white precipitate of calcium carbonate, which is dissolved by an excess of carbon dioxid, owing to the formation of calcium bicarbonate.

In what form and for what is carbon dioxid used in medicine?

It is used in the form of natural and artificial carbonated waters, as Apollinaris and soda water. In medicine these waters are used for their *sedative* and *slightly stimulating* properties, especially in allaying gastric irritation.

CYANOGEN COMPOUNDS

Describe cyanogen and its principal compounds.

Cyanogen; symbol CN; molecular formula C_2N_2. A colorless, inflammable, and highly poisonous gas, liquefiable at a pressure of four atmospheres, with an odor like that of bitter almonds. It burns with a peach-blossom colored flame. It is an *electronegative* organic radical, monad in valency, and forms many very poisonous compounds.

Principal compounds: Hydrocyanic acid, HCN. The dilute acid, containing 2 per cent. by weight of HCN, is the official variety and is called *prussic acid.* It is a colorless, highly poisonous liquid, with an odor resembling that of bitter almonds.

Potassium cyanid, KCN, is a white, opaque solid, odorless when perfectly dry, deliquescent in the air, and giving off the odor of hydrocyanic acid. It is readily soluble in water and very poisonous. Acids decompose it with the formation of hydrocyanic acid. These compounds are employed as *sedatives.*

Give a method for the preparation of cyanogen and hydrocyanic acid.

Cyanogen is readily prepared by heating mercuric cyanid:

$$Hg(CN)_2 + \text{heat} = Hg + C_2N_2.$$

Hydrocyanic acid may be prepared by the action of an acid upon a cyanid, as $KCN + HCl = KCl + HCN$.

METHANE AND ETHENE

What is methane (marsh gas)? Give its formula and chemical importance with a method of preparation.

Methane, also known by the name of *fire-damp*, is a colorless, odorless gas, highly inflammable, producing considerable heat but little or no light.

It may be looked upon as the starting-point in the production of organic compounds. Formula, CH_4.

Preparation: Heating a mixture of sodium acetate and sodium hydroxid with oxid of calcium (lime).

$$NaC_2H_3O_2 + NaOH = Na_2CO_3 + CH_4.$$

What is olefiant gas? Give some of its properties.

Olefiant gas (ethene, ethylene), C_2H_4, is a colorless gas, having an ethereal odor; combustible, and producing a highly luminous flame.

ACETYLENE

Give the formula and properties of acetylene.

C_2H_2.

Acetylene is a colorless gas having an extremely offensive odor which rapidly produces headache; when inhaled pure it is toxic. It is believed to form a distinct compound with the hemoglobin of the blood.

Mention some of the sources of acetylene in the household.

From the incomplete combustion of illuminating gas in gas jets and gas logs especially.

Briefly mention how illuminating gas is manufactured, naming its constituents and why it is toxic.

Illuminating gas is prepared by distilling bituminous coal or by passing steam over red-hot coal.

Constituents: methane, CH_4; ethene, C_2H_4; acetylene, C_2H_2; hydrogen, H; carbon monoxid, CO; carbon dioxid, CO_2; ammonia, NH_3; hydrogen sulfid, H_2S.

Its toxicity is chiefly due to the presence of CO, but partially also to CO_2 and C_2H_2.

SULFUR

Describe the physical and chemical properties of sulfur and name its allotropic forms.

Ordinary *sulfur* is a lemon-yellow, odorless, nearly tasteless, brittle, crystalline solid; insoluble in water, soluble in carbon disulfid, chloroform, turpentine, benzin, and fixed oils.

It is an *electronegative* element having valency of 2, 4, or 6, and forming many important compounds.

Allotropic forms: Prismatic or monoclinic; rhombic, octahedral; plastic or ductile; white.

Give the names and formulas of some of the important compounds of sulfur.

Sulfids: lead (galena), PbS; zinc (zinc blende), ZnS; iron (pyrites) FeS; hydrogen, H_2S.

Sulfates: calcium (gypsum) $CaSO_4$; magnesium (Epsom salt), $MgSO_4$; sodium (Glauber's salt), Na_2SO_4; barium (heavy spar), $BaSO_4$.

Oxids: hyposulfurous, SO; sulfurous, SO_2; sulfuric, SO_3; hypersulfuric, S_2O_7.

Acids: hyposulfurous, H_2SO_2; sulfurous, H_2SO_3; sulfuric, H_2SO_4; hypersulfuric, $H_2S_2O_8$; thiosulfuric, $H_2S_2O_3$ (from which the salts commonly called hyposulfites are obtained).

Discuss the value of sulfur as a germicide.

Sulfur only acts as a germicide when in the form of sulfurous oxid in the presence of moisture. Its germicidal action is due to dehydration and deoxidation of the germs. It is of very little value and has been superseded by more active agents. It is objectionable because of its bleaching action, requiring the removal of all colored fabrics from the space to be disinfected.

DISINFECTANTS AND ANTISEPTICS

What distinction do you make between a disinfectant (germicide) and a deodorant? Give examples of each.

A *disinfectant* is an agent which destroys disease germs and the noxious properties of fermentation and putrefaction. *Examples:* chlorinated lime, formaldehyd, mercuric chlorid.

A deodorant is a substance which removes or corrects offensive odors, but may not destroy disease germs. *Examples:* zinc chlorid, carbolic acid.

Mention some substances used for disinfection after the prevalence of contagious disease and explain their action.

Sulfur when burned yields SO_2, which destroys germs by its dehydrating action. Not very valuable.

Chlorinated lime in solution, when in direct contact with the articles to be disinfected, or acted upon by an acid, yields chlorin gas, which in the presence of moisture unites with the hydrogen, setting free oxygen; the oxygen then destroys disease germs.

Formaldehyd (formalin, 40 per cent. solution of formaldehyd in water) is one of the best disinfectants, acting in its gaseous form.

How do antiseptics differ from disinfectants (germicides)? Give some examples.

An *antiseptic* is any substance that inhibits the growth of micro-organisms, destroys or renders inoccuous the poisonous products of their action upon the tissues of the body, or retards or prevents the absorption of such products. *Examples:* carbolic acid, creolin, boric acid, potassium permanganate.

Disinfectants possess antiseptic attributes, but do not destroy the micro-organisms.

SULFUR COMPOUNDS

Give a method of detecting sulfates in solution.

On the addition of a few drops of hydrochloric acid and barium chlorid a white precipitate, due to the presence of a sulfate, is produced.

In what parts of the body is sulfur found?

In all the albuminous tissues; the sulfates of the urine; the sulfids in the intestines; and in hair, especially red hair.

When sulfur is burned in the air, what is the product and what are its uses?

Sulfur dioxid, SO_2, is the product. It is used as a bleaching and disinfecting agent, and to prevent or limit fermentation; as a *germicide* in skin diseases. In the arts it is employed for the preparation of sulfuric acid, in metallurgy, and as a vulcanizing material.

Describe the physical and chemical properties of SO_2.

A colorless gas with a suffocating odor like that of burning sulfur; soluble in water; neither combustible nor a supporter of combustion. It is an acidic oxid capable of uniting with water to form sulfurous acid, which on exposure to air gradually forms some sulfuric acid. It is the anhydrid of all sulfites, which change gradually to sulfates.

Is sulfurous acid a solid, liquid, or gas at ordinary temperature?

It is a liquid, being the union of sulfurous oxid with water.

Give the properties, impurities, and uses of sulfuric acid. Give methods for detecting the impurities.

When pure it is a colorless, odorless, heavy, oily liquid, having a specific gravity of 1.84. It chars organic matter, which yields a brown to black color to the acid; hence the light brown color of the commercial variety.

Impurities: The most important are *lead* from leaden chamber and pans and *arsenic* from the arsenic which is present in naturally occurring iron sulfid. Lead may be detected by largely diluting the acid with water, when a white precipitate of lead sulfate occurs. Arsenic may be detected by Reinsch's or Marsh's test.

It is more extensively employed in the industries than any other chemic compound: in the manufacture of glucose, the various sulfates of the alkaloids and inorganic salts. In medicine it is used as an *escharotic* in the form of pastes and internally in the form of *aromatic sulfuric acid.*

What is hydrogen sulfid (sulfuretted hydrogen)? Show by equation how it is obtained by the action of hydrochloric acid on calcium sulfid.

A colorless gas having the odor of rotten eggs, soluble in water, and combustible under certain conditions. When inhaled pure it is very toxic.

$$CaS + 2HCl = CaCl_2 + H_2S.$$

Give the formula of hydrogen sulfid and its properties and uses. How may it be detected in solution?

H_2S.

Properties (see also preceding question):—It is used as a reagent for the precipitation of metals as sulfids, especially those of the second group. In medicine it is used as naturally occurring sulfur water in the treatment of *skin diseases* and was formerly employed internally for consumption.

It may be detected by its odor and by bringing paper moistened with lead acetate in contact with it, when black sulfid of lead is formed.

How is hydrogen sulfid formed in nature and how is it ordinarily prepared in the laboratory?

It results from the decomposition of organic matter containing sulfur in the presence of moisture; from putrefaction of proteids in the intestines, and in foul abscesses.

In the laboratory it is prepared by the action of dilute sulfuric acid upon iron sulfid, as shown by the equation: $FeS + H_2SO_4 = FeSO_4 + H_2S$.

PHOSPHORUS

Give (a) the symbol, (b) valence, (c) atomic weight, (d) molecular weight, (e) names of the allotropic forms of phosphorus, with their physiologic action.

(a) P; (b) 1.3.5.; (c) 31; (d) 124; (e) yellow, red, white, and black. They are all poisonous except the red variety.

Give the occurrence in nature, and the properties of phosphorus.

In nature it is never found free, but as phosphates, as in sombrerite and apatite (calcium phosphates). Phosphates are essential to the growth of plants. Phosphorus is a constituent of protoplasm and is present in combination as phosphates in the urine and bones.

It is a translucent, yellowish, wax-like, solid stick, with a garlicky odor; sparingly soluble in water, but freely so in carbon disulfid, ether, and certain oils. It is spontaneously inflammable in air, especially in a finely divided state, and is highly toxic. It emits light in the dark. Chemically it is an *electronegative* (anionic) element, readily combining with oxygen to form oxids, and with chlorin and other elements.

What is the usual source of phosphorus in commerce?

Bone-ash, $Ca_3(PO_4)_2$, after being treated with sulfuric acid, is evaporated to a syrupy consistence and then distilled with charcoal and sand, the phosphorus being collected in molds under water.

Give the names and formulas of the oxids of phosphorus and the acids they form with the elements of water.

Hypophosphorous oxid, $P_2O + 3H_2O = 2H_3PO_2$, Hypophosphorous acid.
Phosphorous oxid, $P_2O_3 + 3H_2O = 2H_3PO_3$, Phosphorous acid.
Phosphoric oxid, $P_2O_5 + 3H_2O = 2H_3PO_4$, Phosphoric acid.

$$P_2O_5 + \begin{cases} H_2O = HPO_3, & \text{Meta, or glacial phosphoric acid.} \\ 2H_2O = H_4P_2O_7, & \text{Pyrophosphoric acid.} \\ 3H_2O = H_3PO_3, & \text{Orthophosphoric acid (common).} \end{cases}$$

Give (a) the commercial and (b) medicinal uses, and (c) medicinal preparations of phosphorus.

(a) In certain alloys, as phosphorus bronze, matches, and insecticides.

(b) As a *tonic reconstructive* to nervous tissues and a *bone producer.*

(c) The only *official preparation* containing the element phosphorus is pilulæ phosphori, coated with balsam of tolu, and containing $\frac{1}{100}$ gr. of phosphorus. Other preparations are phosphoric acid, phosphoric acid dilute, phosphates of metals, as sodium and iron; hypophosphites of metals and of alkaloids.

Describe the method of preparing phosphoric acid and give its properties and uses in medicine.

It may be prepared by warming bone-ash with sulfuric acid, or by treating phosphorus with nitric acid and water in a retort under carefully guarded heat, until all the phosphorus has disappeared. The solution is evaporated until all the nitric acid is expelled. It is a colorless, syrupy liquid, without odor, having a strongly acid taste. It unites with bases to form phosphates.

Medicinally it is rarely employed, being used as the diluted acid, which contains 10 per cent. of the orthophosphoric acid and 90 per cent. of water. It is a *tonic* and *refrigerant*, and is believed to aid digestion.

HALOGENS

(Fl, Cl, Br, I)

Name and give the symbols of the substances called halogens. Why are they so called?

Fluorin, Fl; *Chlorin*, Cl; *Bromin*, Br; *Iodin*, I; Cyanogen, CN (may be considered one of this group).

They are called halogens, "sea-salt producers," because of the close resemblance between their sodium salts and sea salt.

In what respects do the halogen elements exhibit marked similarity, and how do they differ physically?

They are all *monad anionic elements*, capable of forming hydrogen acids and the halogen salts, called *fluorids*, *chlorids*, *bromids*, and *iodids*. They all possess more or less bleaching and disinfecting properties, may exist in the gaseous state, and are toxic. Physically they differ in that fluorin is a colorless gas; chlorin, a greenish-yellow gas; bromin, a reddish-brown liquid, very volatile, yielding reddish-brown fumes; and iodin, a bluish-black, friable solid (rhombic plates), having a metallic lustre and forming violet vapors when heated. They differ in their degree of solubility, bleaching, disinfecting, corrosive, and toxic action. Iodin and chlorin form oxids; bromin and fluorin do not.

Give the properties of chlorin. State the sources and mention the most important of its compounds used in medicine.

Chlorin is a greenish-yellow gas, very irritating to the mucous membranes, suffocating and poisonous; soluble in water; a bleaching and disinfecting agent.

With hydrogen it forms hydrochloric acid, and with metals, salts called chlorids, being an electronegative, monad element.

Sources: From sodium chlorid and other chlorids in nature. It may be obtained by heating hydrochloric acid and manganese dioxid, as $4HCl + MnO_2 = MnCl_2 + 2H_2O + Cl_2$; or heating sodium chlorid, manganese dioxid with sulfuric acid, as $2NaCl + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnCl_2 + 2H_2O + Cl_2$; or heating chlorinated lime (chlorid of lime (commonly), chlorohypochlorite of calcium) alone or with an acid, as—

$$CaClOCl + H_2SO_4 = CaSO_4 + H_2O + Cl_2.$$

Compounds used in medicine: Sodium chlorid, mercurous chlorid, mercuric chlorid, ferric chlorid, arsenious chlorid, zinc chlorid, cocain chlorid (hydrochlorid, muriate).

How is chlorin prepared and how is it administered medicinally by the mouth?

Preparation.—See preceding question, under Source.

Administration.—In the form of chlorin water (liquor chlori compositus), and in the form of salts, as chlorids.

(a) In what compound is chlorin found most abundantly in nature? (b) Upon what do the bleaching and disinfecting properties of chlorin depend?

(a) Sodium chlorid, NaCl.

(b) Upon the intense affinity of chlorin for hydrogen in water, with which it unites to form hydrochloric acid, liberating the oxygen, which in its nascent state is the really active agent in destroying colors, odors, germs, and their products. Chlorin acts as a bleaching or disinfecting agent only in the presence of moisture.

How is chlorinated lime made and what are its principal uses?

By passing chlorin gas over slaked lime spread in thin layers upon shelves in a specially constructed room.

$$Ca(OH)_2 + Cl_2 = CaClOCl + H_2O.$$

It is used chiefly as a *bleaching* and *disinfecting* agent. When exposed to the air or brought in contact with an acid it yields chlorin, which acts in the manner described in the preceding question.

What acid contains chlorin as an important element?

Hydrochloric acid (muriatic acid), HCl.

Describe hydrochloric acid as to (a) occurrence, (b) preparation, (c) physical, and (d) chemical properties.

(a) It occurs in volcanic gases, in the air over chemical works where it is being manufactured, and in the gastric juice of animals.

(b) By heating sodium chlorid with sulfuric acid, as—

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl,$$

the gas being collected in water and by appropriate means brought to a definite strength, in which form it appears in commerce as "muriatic acid."

(c) It is a colorless, poisonous gas, very irritating to the respiratory passages, and with a strong acid taste. It is very soluble in water, forming the liquid ordinary called hydrochloric acid.

(d) It is a hydrogen acid forming with metals or basic substances salts called chlorids.

Name the principal sources (occurrence in nature) of bromin and give its uses in medicine.

Bromin is present in natural mineral waters and the sea, in the form of bromids, from which it may be obtained as stated in next question.

It is used for the preparation of *bromids*, as sodium, potassium, ammonium, gold, arsenic, iron bromids, which are used in medicine. It is employed in the preparation of sodium hypobromite required in urinalysis for the determination of urea. It is rarely employed as a caustic in the treatment of gangrene and large sloughs.

Describe the properties of bromin and give a method for its preparation.

Properties: See page 58, second question.

Preparation: It is chiefly prepared from the "mother liquor" of salt wells, which contains magnesium and sodium bromids, by evaporating it to dryness, mixing the residue with manganese dioxid and sulfuric acid, and distilling.

Equation: $MgBr_2 + MnO_2 + 2H_2SO_4 = MgSO_4 + MnSO_4 + 2H_2O + Br_2.$

Give the properties and uses in medicine of the salts of bromin.

The *bromids* are soluble salts except those of silver, lead, bismuth, copper and tin, and mercurous and mercuric bromids. They are used as *sedatives* and *depressants.*

Give the occurrence, preparation, properties, important compounds, and medicinal uses of iodin.

Iodin occurs in sea-weeds and in sea-water as iodids and organic compounds.

Preparation: The ash of sea-weeds (kelp, varec, barilla) is lixiviated, the solution concentrated, mixed with manganese dioxid and sulfuric acid, and distilled.

Equation: $2NaI + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + I_2$. It is purified by resublimation.

Properties: See page 58, second question.

Compounds: Iodids of potassium, KI; sodium, NaI; ammonium, NH_4I; mercurous, HgI; mercuric, HgI_2; strontium, SrI_2; iodoform, CHI_3.

Medicinal uses: As an *eliminant* in metallic poisoning, as lead, zinc, arsenic, or mercurial poisoning, and in certain diseases. As an *antisyphilitic*, *antirheumatic*, a *germicide*, and externally, as free iodin, as a *counterirritant.*

Describe the preparation of potassium iodid, giving the equation that represents the chemical reaction, and name some of its uses.

Saturate an aqueous solution of caustic potash with iodin. Evaporate the solution to dryness; the residue, which consists of potassium iodid and iodate, is then strongly heated to decompose the iodate, thus forming iodid with the liberation of oxygen. Dissolve the mass in water, which upon evaporation yields cubic crystals of potassium iodid.

Equation: $6KOH + 3I_2 = 5KI + KIO_3 + 3H_2O$.
$2KIO_3 + \text{heat} = 2KI + 3O_2$.

Uses: As an *alterative;* see preceding question, Uses of Iodin.

How may the presence of iodin in the form of an iodid in solution be detected?

If iodin is present it is liberated by the addition of chlorin water to the solution, and if the latter is shaken up with chloroform or carbon disulfid, the iodin is dissolved and collects at the bottom of the test-tube, forming a *pink* to *violet* or *dark purple color.*

SILVER
(Ag)

Describe the element silver and give the names of its most important compounds and their uses in medicine.

Silver is a pure white, brilliant metal; specific gravity, 10.5. It is malleable, ductile, a good conductor of heat and electricity. It does not

oxidize in the air, but readily tarnishes in air containing traces of hydrogen sulfid.

Compounds: Silver nitrate, used in solution locally as a *caustic* and as lunar caustic, which is $AgNO_3$ fused with HCl and moulded into sticks, and as a *stimulant*; internally, in pill form as an *astringent* and *alterative*.

Argyrol, protargol, and other new compounds of silver with organic substances are used as substitutes for silver nitrate, as germicides, astringents, etc.

Pure *silver wire* is used in surgery.

What salt of silver is commonly used in medicine? Give its formula, preparation, and properties.

Silver nitrate was the most commonly used, but is being superseded by the new organic compounds above mentioned. *Formula:* $AgNO_3$.

Preparation: Pure silver is dissolved with pure nitric acid and water in a flask under the action of heat. The solution is evaporated and the silver nitrate allowed to crystallize out. It is further purified by recrystallization.

It is a colorless, odorless, transparent, tabular, rhombic, crystalline solid, with a bitter, caustic, metallic taste, neutral reaction, becoming gray or black on exposure to light in the presence of organic matter. See preceding question (b), for its other properties.

Give a test for silver in the form of silver nitrate in solution.

Hydrochloric acid or a soluble chlorid yields a white precipitate of silver chlorid, AgCl, insoluble in nitric acid, soluble in ammonium hydroxid, from which solution it is reprecipitated by neutralization with nitric acid.

LEAD
(Pb)

Give (a) the symbol, (b) atomic weight, (c) valence, and (d) physical properties of lead.

(a) Pb; (b) 206.9; (c) diad and tetrad.

(d) *Lead* is a soft, bluish-white, ductile, malleable metal, which when freshly cut exhibits a bright metallic luster. On exposure to air the bright surface becomes quickly covered with a film of oxid. Specific gravity 11.4.

Give (a) the chemical and (b) pharmaceutical name and (c) the formula of sugar of lead, and of litharge.

Sugar of lead: (a) Plumbic acetate; (b) plumbi acetate; (c) $Pb(C_2H_3O_2)_2 + 3H_2O$.

Litharge: (a) Lead oxid; (b) plumbi oxidum; (c) PbO.

Give some tests for lead in solution in the form of a salt.

1. Hydrochloric acid yields a *white* precipitate of lead chlorid, $PbCl_2$, soluble in hot water, from which it crystallizes on cooling.
2. Potassium chromate yields a *yellow* precipitate of lead chromate (chrome yellow), $PbCrO_4$.
3. Sulfuric acid produces a *white* precipitate of lead sulfate, $PbSO_4$.
4. Potassium iodid produces a *yellow* precipitate of lead iodid, PbI_2, soluble in hot water, from which it crystallizes in shining, yellow leaflets.

Give the toxicology of lead.

Lead may cause acute or chronic poisoning. In the *acute form* lead acts as an irritant, causing epigastric pain, vomiting, intestinal colic with diarrhea due to gastro-enteritis, or obstinate constipation.

In the *chronic form* (plumbism) lead causes paralysis of the extensor muscles, producing bilateral "wrist-drop," intestinal colic with obstinate constipation, blue line on the gums, anesthesia, and paralysis. Persons constantly using a pure water which has passed through a lead pipe or who are exposed to the fumes of lead and its compounds are especially subject to the latter form of poisoning.

The chemical *antidote* is a soluble sulfate, as Epsom or Glauber's salt, which produces insoluble lead sulfate.

MERCURY

(Ag)

What metal is liquid at ordinary temperature?

Mercury, hydrargyrum (quicksilver).

How does mercury occur in nature? Give its physical and chemical properties, and name and give the formulas of some of its compounds used in medicine.

It is found free and in combination as a sulfid, HgS (cinnabar), in California, Spain, Mexico, and other countries.

Mercury is a bright, silver-white, liquid metal; specific gravity 13.59. It does not tarnish on exposure to air, but when heated is slowly converted into the red oxid.

It is an *electropositive* element, capable of uniting with anionic elements and forming a large number of compounds, which are of two varieties—mercur*ous* and mercur*ic*.

Compounds used in medicine: Mercurous chlorid (calomel), $HgCl$; mercuric chlorid (mercury bichlorid, corrosive sublimate), $HgCl_2$; mercurous iodid, HgI; mercuric iodid, HgI_2; mercurous oxid, Hg_2O; mercuric oxid, HgO; mercuric nitrate, $Hg(NO_3)_2$.

Give the properties of (a) calomel, (b) corrosive sublimate, and give (c) two tests which will distinguish one from the other.

(a) *Calomel* is a white, odorless, tasteless, impalpable powder, permanent in the air, insoluble in water. It is a cholagogue *purgative* and *diuretic*.

Corrosive sublimate is a heavy, colorless, odorless, crystalline solid, having an acrid metallic taste, permanent in air, and soluble in water. It is an *alterative*, *antisyphilitic*, *antiseptic*, and a violent corrosive poison.

(c) Calomel treated with ammonium hydroxid produces a *black solid* of mercurous ammonium chlorid.

Corrosive sublimate with ammonium hydroxid yields a *white* precipitate of mercuric ammonium chlorid. Calomel is *insoluble* in water, corrosive sublimate is *soluble*.

What mineral acids are incompatible with mercurous chlorid? Give the formula and synonym of mercurous chlorid.

Nitric, hydrochloric, and nitrohydrochloric acids, as they change it from an insoluble, nonpoisonous compound to the mercuric condition, in which form it is soluble in water and highly toxic.

Formula, etc.: See page 62, third question, under compounds used in medicine.

Give the formula, synonyms, and properties of (a) mercurous iodid, (b) mercuric iodid.

(a) HgI, *hydrargyri iodidum flavum*, green iodid of mercury, yellow iodid of mercury, mercury protoidid.

It is a bright yellow or greenish yellow, amorphous powder, odorless and tasteless, almost insoluble in water. On exposure to light it decomposes into metallic mercury and mercuric iodid. It is an *alterative*, *antisyphilitic*, and *germicide;* less poisonous than mercuric iodid.

(b) HgI_2, *hydrargyrum iodidum rubrum*, red iodid of mercury, mercury biniodid. It is a scarlet red, amorphous powder, odorless and tasteless, almost insoluble in water. It is an *alterative*, *antisyphilitic*, *germicide*, and a powerful irritant poison.

What compound is formed by a mixture of mercuric salts and potassium iodid?

Mercuric iodid, HgI_2, soluble in an excess of potassium iodid, forming potassiomercuric iodid. See page 37, third question.

What is the chemical antidote of mercuric chlorid and what is the general treatment in a case of poisoning?

There is no individual chemical antidote, but *albumin* (white of egg), *tannin*, *lime-water*, *copper salts*, and *vegetable astringents* all yield insoluble compounds with mercury, which must be removed from the stomach by emetics or the stomach-pump. Afterward the stomach must be washed out with white of egg in water or milk, the pain relieved with morphin, and stimulants, such as brandy, administered, if necessary.

Name the preparations containing metallic mercury that are used in medicine.

Massa hydrargyri (blue mass); unguentum hydrargyri (mercurial ointment); hydrargyrum cum creta (mercury with chalk, gray powder); emplastrum hydrargyri (plaster of mercury).

Name two compounds of mercury and chlorin frequently used in medicine, and state how they may be distinguished from each other.

Calomel and corrosive sublimate (see page 62, last question).

POTASSIUM
(K)

Name three elements in the potassium group.

Potassium, sodium, lithium.

Where does potassium occur?

In combination only, as saltpeter, KNO_3; feldspar, carnallite, and in vegetables; and in the tissues of animals as organic compounds.

Give the properties of potassium and give the names and formulas of some of its most important compounds used in medicine.

Potassium is a soft, wax-like metal, having a silver-white luster when freshly cut, and rapidly oxidizing in the air. It decomposes water violently, yielding $KOH+H$. It is one of the most powerful alkalies.

Compounds: Potassium iodid, KI; potassium cyanid, KCN; potassium bromid, KBr; potassium chlorate, $KClO_3$; potassium carbonate, K_2CO_3; potassium nitrate, KNO_3; potassium permanganate, $KMnO_4$; potassium bitartrate, $KHC_4H_4O_6$.

Describe some of the more important potassium salts.

Potassium bromid is a colorless, odorless, cubic crystalline solid having a strong saline taste and neutral reaction; soluble in water and glycerin.

Potassium acetate is a colorless, crystalline solid of a satin-like luster, odorless, and having a warming, saline taste. It is very deliquescent in the air.

Potassium bitartrate (cream of tartar) occurs in colorless or slightly opaque, rhombic crystals, or a white, somewhat gritty, odorless powder, having a pleasant acidulous taste.

Give a method for the preparation, properties, and uses of potassium cyanid.

Potassium cyanid is prepared by saturating a solution of caustic potash with hydrocyanic acid. It is a white, opaque, amorphous solid; or a white granular powder, odorless when perfectly dry; deliquescent in the air and exhaling the odor of hydrocyanic acid. It is very poisonous.

Uses: As a sedative for cough and in cardiac disturbances.

Give the properties and uses of potassium permanganate.

Potassium permanganate is a crystalline solid, forming slender monoclinic prisms, and having a dark, reddish-purple color. It is odorless, and the taste is at first sweet, afterward disagreeable and astringent. It is soluble in water, forming a purple solution neutral to litmus.

Uses: As a *disinfectant*, because of its oxidizing properties and as an *antidote* to *morphin.*

SODIUM

(Na)

(a) Where does sodium occur in nature? (b) Give the names and formulas of three sodium salts used in medicine.

Sodium is chiefly found in its most common salt, sodium chlorid, which is present in sea-water, natural spring waters, and in the fluids of animals. It is also found as other compounds, but never in the free state in nature.

(b) Sodium chlorid, NaCl; sodium iodid, NaI; sodium bromid, NaBr.

What is common salt? (a) How is it obtained? (b) Give the manner in which it acts when used in freezing mixtures.

Sodium chlorid, NaCl.

(a) By crystallization from natural waters containing it, or from solutions obtained by forcing water through salt-bearing rock formation, or by mining it.

(b) When salt is mixed with snow or ice, the affinity of the salt for water causes a liquefaction of the snow or ice. To produce this change heat is required. This heat is obtained from substances in contact with the mixture. When the substances are liquid or gaseous, the amount of heat abstracted may be sufficient to cause liquids to become solid, and gases to become liquid or solid.

LITHIUM
(Li)

Describe lithium as to (a) occurrence, (b) properties, (c) salts commonly used in medicine, (d) the chemistry of its use in so-called rheumatic affections.

(a) It is only found in combination in small quantities, but widely disseminated in some mineral springs, in the ash of many plants, and in the form of compound silicate, as lepidolite.

(b) It is a soft, silver-white metal, readily tarnishing on exposure to the air, like sodium. It is the lightest known solid, specific gravity, 0.59. It decomposes water and forms compounds similar to the potassium and sodium compounds.

(c) Lithium bromid, LiBr; lithium carbonate, Li_2CO_3; lithium citrate, $Li_3C_6H_5O_7 + H_2O$; lithium salicylate, $LiC_7H_5O_3$; lithium benzoate, $LiC_7H_5O_2$.

(d) Lithium being an alkali, certain of its salts, as the carbonate and citrate, readily give up their lithium to uric acid in the body, forming *lithium urate,* which is soluble in the fluids of the body and eliminated by the kidneys. It was believed that lithium salts dissolve calculi, but this is not true. The lithium salts are used to render the urine *alkaline.*

ALKALINE EARTH METALS

Name some of the elements in the calcium group and give their general characteristics.

Calcium, strontium, barium, magnesium, and radium. They are alkaline in character, forming oxids and salts somewhat similar to the alkali metals. They are silvery-white or gray solids having a diad valency.

Give the name and formula of a compound of three of the alkaline earth metals used in medicine.

Calcium chlorid, $CaCl_2$; strontium salicylate, $Sr(C_7H_5O_3)_2$; magnesium sulfate, $MgSO_4$.

Give (a) the symbol, (b) occurrence in nature, (c) physical properties, and (d) uses of calcium.

(a) Ca.

(b) *Calcium* is widely distributed in nature as the carbonate (limestone, marble, chalk) and the sulfate (gypsum); as phosphate, fluorid, and silicate.

(c) It is a silver-white metal, stable in dry air, but in moist air becoming covered with a layer of hydrate. It decomposes water, yielding hydrogen. It burns with a yellow light at a high temperature.

(d) It is used as carbonate for building purposes; as sulfate for moulding and modeling; and in many pharmaceutic preparations, as *calcium hydroxid* (*lime-water*), *creta preparata*, *mistura cretæ*, etc.

Give the chemical name and properties of (a) cream of tartar, (b) plaster of Paris.

(a) Potassium bitartrate (see page 64, third question).

(b) *Calcium sulfate* ($CaSO_4 + 2H_2O$), which is partially deprived of its water of hydration by heat, converting it into the hydrate $(CaSO_4)_2H_2O$. It is a fine white powder, odorless and tasteless, which with water forms a smooth, cohesive, rapidly hardening paste.

ZINC
(Zn)

Give the names and formulas, physical and medicinal properties, and the uses of three important salts of zinc.

Zinc oxid, ZnO, is a fine white or yellowish-white powder, odorless, tasteless, and *insoluble* in water. It is an *astringent* and *antispasmodic;* rarely used internally, but externally as an *exsiccant* to excoriated surfaces, in the form of powder or ointment.

Zinc sulfate, $ZnSO_4$, is a colorless, transparent, crystalline solid, or a granular powder, odorless, having an astringent, metallic taste, and *soluble* in water. It is an *astringent* and *emetic*, employed in aqueous solutions for local applications, as a gargle, injection, spray, and eye-wash.

Zinc phenolsulfonate (*sulfocarbolate*) is a colorless, transparent crystalline solid, odorless, having an astringent, metallic taste, *soluble* in water and efflorescent in the air. It is an *astringent* and *antiseptic*, used in solution as an antiseptic wash and internally as an *intestinal antiseptic.*

Give the common name and a method of preparation of zinc sulfate.

White vitriol is the common name.

Preparation: Zinc carbonate treated with sufficient sulfuric acid.

BORON
(B)

What is boron and from what is it obtained?

Boron appears in the form of a brownish or yellowish, non-metallic, amorphous powder or octahedral crystals. The crystals are infusible and next to diamond in hardness. It is obtained from boric acid or borax.

Give the names of the principal compounds, and the chemical importance in medicine of boron.

Boric acid, H_3BO_3, and *borax*, $Na_2B_4O_7 + 10H_2O$.

Boron is important in medicine only in the form of its two compounds, boric acid and borax, which have *detergent*, *antiseptic*, and *astringent* properties. It is one of the constituent elements of the human body.

Give (a) the formula, (b) occurrence in nature, (c) preparation, (d) properties, and (e) medical uses of boric acid.

(a) Boric acid (boracic acid) H_3BO_3.

(b) It occurs in solution in natural waters, as borax and other salts.

(c) It may be prepared by evaporating the natural waters containing it and allowing it to crystallize, or by treating borax with hydrochloric acid.

(d) It occurs in transparent, colorless scales of a somewhat pearly luster, or in hexagonal triclinic crystals, or in the form of a light, white, very fine powder, slightly unctuous to the touch; odorless, having a faintly bitter taste, and permanent in the air. It is soluble in eighteen parts of water at ordinary temperature. It is an *antiseptic*, but not a germicide. Externally it has a *detergent*, soothing, and *antiseptic* action. It is used as a lotion for the eyes and mouth, for cleansing wounds, and in certain skin disorders.

ALUMINIUM
(Al)

Give the properties of aluminium and mention its important salts.

Aluminium is a bluish-white, silvery metal, not readily acted upon by the air. A thin film of oxid protects it from rust. It is the lightest of metals, having a specific gravity of 2.7. It is malleable and used for household articles and building purposes.

Its important salts are the various *alums*, as the ammonium and potassium alums.

Name and give the general characteristics of the aluminium group of elements.

They are aluminium, gallium, indium, scandium, etc. They form trivalent ions forming salts like $AlCl_3$, $Al_2(SO_4)_3$. Their oxids are weak bases.

Give the formula and properties of common alum.

The most common alum is the *ammonium alum*, $NH_4Al(SO_4)_2 + 12H_2O$; the official alum is *aluminium potassium sulfate*, $AlK(SO_4)_2 + 12H_2O$.

It is a white, translucent, crystalline, efflorescent compound, having a sweetish, astringent taste and an acid reaction. It is *soluble* in water and has *astringent* and *styptic* properties.

BISMUTH
(Bi)

Give (a) the symbol, (b) atomic weight, (c) occurrence in nature, and (d) the compounds used in medicine of bismuth.

(a) Bi; (b) 208.5.

(c) *Bismuth* occurs in the form of an oxid, a sulfid with arsenic and tellurium.

(d) Bismuth *subnitrate*; bismuth *subgallate*; bismuth *subsalicylate*; bismuth *citrate*.

To what are (a) the so-called bismuth breath, and (b) the toxic action of bismuth subnitrate due?

(a) Tellurium oxid.

(b) Arsenic, which is generally present in the bismuth ores from which the compounds of bismuth are produced.

By what tests can a determination be obtained as to whether a given powder is bismuth subnitrate or calomel?

1. Bismuth subnitrate is more soluble in water than calomel.
2. By fusion bismuth subnitrate yields metallic bismuth, which is solid; while calomel yields liquid mercury, which partly volatilizes and partly forms some red oxid of mercury.
3. A solution of bismuth subnitrate and ammonium hydroxid yields a white precipitate, while calomel turns black when treated with ammonium hydroxid.

IRON
(Fe)

Name and give the general characteristics of the metals of the iron group.

Iron, cobalt, and nickel.

They are diads, malleable, ductile, of considerable tenacity, and have a high melting-point. They decompose water at a red heat. Their oxids, hydroxids, carbonates, and phosphates are insoluble; their salts in alkaline solution are precipitated as sulfids by hydrogen sulfid.

What is iron, chemically, and (a) which one of its preparations is used in obtaining pharmaceutic preparations?

Iron, when pure, is a gray-white metal, having a specific gravity of 7; very tenacious, ductile, and malleable. It oxidizes in moist air, is soluble in acids, as sulfuric, nitric, and hydrochloric, forming salts.

(a) *Ferrous sulfate.*

Give the names and formulas of the salts of iron commonly used in medicine.

Ferric *chlorid*, $FeCl_3$; ferric *iodid*, FeI_3; ferric *acetate*, $Fe(C_2H_3O_2)_3$. Ferrous *sulfate*, $FeSO_4$; ferrous *carbonate*, $FeCO_3$.

What is reduced iron (ferrum reductum) and how is it obtained?

It is iron in a very fine, lusterless, grayish-black powder, odorless and tasteless. It is obtained by passing hydrogen over hydrated oxid of iron heated to redness, which reduces it to iron by withdrawing the oxygen and forming water.

How is ferric chlorid made? Give the chemical equation.

By dissolving fine iron wire in aqua regia, or by acting upon the iron with free chlorin.

$$Fe_2 + 6HCl + 2HNO_3 = 2FeCl_3 + 2NO + 4H_2O.$$

Why is iron prescribed in anemic conditions?

To supply the hemoglobin of the blood with the necessary element to carry oxygen and make red blood-corpuscles.

ARSENIC
(As)

Give (a) the chemical properties and (b) name some compounds with formulas of arsenic.

(a) *Arsenic* is a steel-black *nonmetal* with a metallic appearance, lying on the border-line of metals and nonmetals; very brittle, unoxidized in dry air, but when heated in oxygen, burning with a bluish-white flame and producing arsenious oxid. It is *electronegative* in character; combines with hydrogen and metals to form arsenids, and with oxygen to form oxids. Its soluble salts are very *toxic*.

(b) Arsenious oxid (trioxid, anhydrid, white arsenic) As_2O_3; arsenic oxid (pentoxid), As_2O_5; *arsenious iodid* (arseni iodidum), AsI_3; *sodium arsenate* (sodii arsenas), $Na_2HAsO_4+7H_2O$; *Fowler's solution*, which contains potassium arsenite.

What compound of iron is used as an antidote for arsenic, (a) Write the equation showing the reaction of the antidote. (b) How may th antidote be rapidly prepared?

Ferric oxyhydroxid, hydrated oxid of iron (ferri hydroxidum cum magnesii oxido).

$$\text{(a) } 4Fe(OH)_3 + As_2O_3 = Fe_3(AsO_4)_2 + Fe(OH)_2 + 5H_2O, \text{ or}$$
$$Fe(OH)_3 + 2H_3AsO_3 = Fe_3(AsO_4)_2 + FeO + 9H_2O.$$

The ferrous arseniate, $Fe_3(AsO_4)_2$, is insoluble, therefore nonpoisonous.

(b) By mixing a dilute solution of ferric sulfate or ferric chlorid with magnesium oxid and water, and thoroughly shaking. The entire mass is given at once.

How would you proceed to detect the presence of arsenic in a case of suspected poisoning?

First obtain the contents of the stomach by causing vomiting, if that has not occurred, or by the use of the siphon tube. A portion of the material thus obtained is carefully examined under the microscope for solid arsenious oxid.

Reinsch's test is applied to another portion as follows: The portion taken is acidulated with about one-seventh its volume of hydrochloric acid, a clean piece of metallic copper-foil placed in the solution, and the whole heated and kept almost at the boiling-point for several minutes. In this hot solution the arsenic is deposited on the copper-foil as a grayish or black coating. The foil is taken from the solution and carefully washed with water, then pressed (not rubbed) between filter paper to free it from adherent moisture, and finally completely dried by being warmed on a piece of filter paper held quite a distance above a Bunsen flame. It is then placed in a constricted glass tube near the contracted part, the tube inclined, and the

part containing the foil gently heated. Volatilization of the arsenic and combination with oxygen of the air take place, and colorless octahedral crystals of arsenious oxid are deposited in the cooler constricted part of the tube, which are readily recognized by means of the microscope.

Another portion may be tested by Marsh's test (see next question).

Describe Marsh's test for arsenic and give the equations occurring in the reaction.

Pure metallic zinc is placed in a flask with dilute pure sulfuric acid, and the hydrogen thus produced is passed through a drying tube containing calcium chlorid, and through a reduction tube of hard glass, free from lead, until the apparatus is completely filled with hydrogen.

The unconstricted portion of the tube is heated to redness for about fifteen minutes. If no brown or black deposit is produced in the constricted part of the tube in advance of the part heated, the materials used may be considered free from arsenic. A small quantity of the arsenic solution is then introduced into the funnel-tube attached to the flask and washed into the flask with a little dilute sulfuric acid. The arsenic unites with the nascent hydrogen, forming hydrogen arsenid gas, which, coming in contact with the heated part of the glass tube, decomposes with the production of a brown to black, metallic-like deposit of arsenic.

Instead of heating the tube, the gas may be ignited as it issues from the tube and brought in contact with a cold porcelain surface, when the same deposit occurs.

Antimony yields similar results and may be distinguished from arsenic by the deposit being insoluble in sodium hypochlorite, while arsenic is soluble.

Give a reduction test for arsenic.

Mix arsenious oxid with dry, powdered charcoal and sodium carbonate, and heat the whole in a plain or bulbous reduction tube. The arsenious oxid is deoxidized, yielding a sublimate of black arsenic in the tube, just beyond the point of heating.

How may the presence of arsenic in wall paper be detected?

The wall paper is warmed with nitric and sulfuric acids, which oxidizes any arsenic present to arsenic acid. The action is continued until the organic matter has been destroyed and the excess of acid evaporated. The mixture thus obtained is diluted with water and Marsh's test applied, as given above.

Give the method of preparation of Fowler's solution and name the important salts it contains.

Dissolve *one* part arsenious oxid and *two* parts potassium bicarbonate in *ten* parts of distilled water by boiling. Then add enough distilled water to make ninety-seven parts and add three parts compound tincture of lavender. Filter through paper.

The important salts are *potassium arsenite*, K_3AsO_3, and *potassium metarsenite*, $KAsO_2$.

ANTIMONY
(Sb)

What are the properties of antimony (stibium)?

Antimony is a brilliant, gray-white solid, of a leafy, crystalline structure; odorless, tasteless, and very brittle. Specific gravity, 6.7. Volatile under the action of heat, forming Sb_2O_3. In the finely divided state it takes fire in chlorin gas, forming antimony chlorid. It increases the hardness of alloys and lowers the fusing-point. Its compounds are *toxic*.

How is antimony found in nature?

It occurs chiefly in union with sulfur as stibnite, Sb_2S_3, and with sulfur and metals in many ores. It is almost always accompanied by arsenic.

Give (a) the chemical name, (b) properties, and (c) uses of tartar emetic.

(a) *Antimony-potassium tartrate* (antimonii et potassii tartras), $(KSbOC_4H_4O_6)_2+H_2O$.

(b) It is a colorless, transparent, crystalline solid, becoming opaque on exposure to the air; or a white, granular powder, odorless, with a sweetish, afterward disagreeable metallic taste. It sublimes when heated. It is very *poisonous*.

(c) It is used as an *emetic* and as a *sedative expectorant*.

ORGANIC CHEMISTRY

What is organic chemistry? State the general properties of organic compounds.

Organic chemistry is the chemistry of the carbon compounds; or it is the chemistry of the hydrocarbons and their derivatives, including cyanogen and its compounds.

Properties: Organic compounds contain carbon and therefore, upon burning, char. When pure they are completely consumed under continued heat; any residue remaining after the disappearance of the char indicates the presence of mineral matter. They are the essential compounds of plant and animal structures and their molecular composition may be very complex, but includes only a few elements.

Differentiate between hydrocarbons and carbohydrates.

Hydrocarbons are compounds of hydrogen and carbon, as CH_4, methane; C_2H_5, ethyl.

Carbohydrates (see page 95).

Name the principal derivatives of the hydrocarbons.

Alcohols, ethers, chloroform, iodoform, aldehyds, and fat acids.

Name four elements that enter into the formation of most organic bodies.

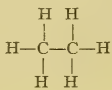
Carbon, hydrogen, oxygen, and nitrogen.

What is the relative importance of the element carbon in organic chemistry?

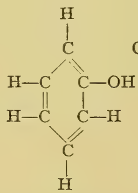
Carbon is the essential element in all organic bodies, distinguishing organic from inorganic compounds, although a few inorganic compounds contain carbon, such as the carbonates and bicarbonates.

What do you understand by the (a) open= and (b) closed= chain series? Give an example of each.

(a) Open chain or aliphatic compounds are those derived from methane, in which the carbon atoms are united in series.

Example:  = C_2H_6, ethane.

(b) Closed-chain, cyclic, or aromatic compounds are those in which the carbon atoms are united in the form of a ring or nucleus and are derived from benzene.

Example:  C_6H_5OH, phenol.

Give the sources, and name the uses of benzene.

Benzene is obtained by the distillation of coal-tar, benzoic acid, or benzoates, the two latter being mixed with calcium oxid in the process.

It is used as the mother substance in the production of a very large number of aromatic compounds, many of which are of importance in medicine. *Examples:* anilin and all the anilin compounds, phenol, salicylic acid, resorcin.

It is also used as a solvent for fats, oils, resins, and many other organic compounds.

(a) Give the formula, (b) occurrence in nature, (c) the properties, and (d) uses in medicine of salicylic acid.

(a) $HC_7H_5O_3$.

(b) *Salicylic acid* is found in oil of wintergreen (gaultheria) as methyl salicylate, and in coal-tar.

(c) It occurs as fine, white, needle-shaped crystals, odorless, sweetish, acrid taste, sparingly soluble in water, soluble in alcohol, ether, and chloroform.

(d) It is used as an *antirheumatic*, *antiseptic* and *disinfectant*, and as a preservative.

From what oil may salicylic acid be obtained? How is it now manufactured? Give a test tor salicylic acid.

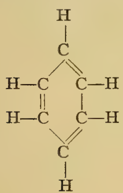
It may be obtained from oil of wintergreen, the source from which salicylic acid was originally derived. It is now manufactured by treating carbolic acid with caustic soda, forming sodium carbolate. This is saturated with carbon dioxid under pressure, and heated to 200° C., forming *sodium salicylate.*

$$\underset{\text{Sodium carbolate.}}{C_6H_5ONa} + CO_2 = \underset{\text{Sodium salicylate.}}{C_6H_4OH.COONa.}$$

The salicylic acid in this salt is then set free by the addition of hydrochloric acid. Salicylic acid with ferric chlorid produces a *violet* color.

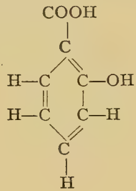
Give the graphic formula of (a) benzene and (b) salicylic acid.

(a)



$= C_6H_6.$

(b)



$= C_6H_4OHCOOH.$

(a) What is creosote? (b) How is it prepared? (c) Describe its properties and (d) give its uses.

(a) *Creosote* is a complex mixture of phenols, especially guaiacol, creosol, and cresol.

(b) It is obtained by distilling wood-tar or coal-tar.

(c) It is a yellow or brownish, oily liquid with a smoky odor and burning taste, *soluble* in one hundred and fifty parts of water, freely soluble in other solvents, except glycerin.

(d) It is used locally for toothache and as a caustic for warts. Mostly used for its *antiseptic* properties.

Distinguish creosote from carbolic acid.

Creosote is less soluble than carbolic acid, is not crystalline, does not coagulate collodion, and with ferric chlorid gives a *transient brown*, instead of a violet color.

What are amins? Give an example.

Amins are substitution compounds of ammonia in which one or more atoms of hydrogen are replaced by a basic organic radical. *Example:* ethylamin, $NH_2C_2H_5$.

What are amids? Give an example.

Amids are substitution compounds of ammonia in which hydrogen is replaced by an acid radical. They result when NH_2 replaces OH in acids. *Example:* carbamid (urea), $(NH_2)_2CO$.

Saccharin belongs to what class of compounds? What is its source? Give its properties and uses in medicine.

Saccharin (benzosulphinidum) is an amin compound obtained from coal-tar. It is a white, crystalline powder, nearly odorless, of intensely sweet taste (two hundred and eighty times sweeter than cane-suger), soluble in two hundred and fifty parts of water, readily soluble in alcohol and ether.

It is used in medicine to replace sugar for sweetening purposes in cases of *diabetes* and *gout*.

(a) How is anilin obtained? (b) State how anilin dyes are manufactured from anilin. (c) Name some compounds of anilin used in medicine.

(a) Anilin (phenylamin) is obtained by reducing nitrobenzen with hydrogen.

$$\underset{\text{Nitrobenzen.}}{C_6H_5NO_2} + 3Fe + 6HCl = \underset{\text{Anilin.}}{C_6H_5NH_2} + 3FeCl_2 + 2H_2O.$$

(b) Anilin dyes are prepared by substituting some of the hydrogen of anilin by various radicals.

(c) Acetanilid, phenacetin.

Define substitution as understood in organic chemistry.

Substitution is the replacement of an element or group of elements in a compound by another element or group of elements, thus producing a new compound which exhibits the type of the compound from which it was produced.

Give the difference between essential (volatile) oils and fixed oils. Give examples of each.

Essential oils are the oils of plants and belong to the class of compounds known as terpenes. They have the formula, $C_{10}H_{16}$, and are volatile liquids. They do not form glycerin when treated with an alkali.

Examples: oil of turpentine, lemon, bergamot, juniper, and rosemary.

Fixed oils are the true fats and are composed of the glyceryl radical combined with a fat acid radical. When treated with an alkali they form glycerin and soap. *Examples:* stearin, palmitin, olein.

What is turpentine and what is its source?

Turpentine is a terpene (essential oil) obtained from the juice of the pine.

What is terebene? Describe its properties and uses.

Terebene is the liquid obtained by the action of sulfuric acid on oil of turpentine. It is a yellowish liquid of thyme-like odor and aromatic taste. On exposure to light it forms resin. It is sparingly soluble in water, freely in alcohol and ether. It is used as an *external antiseptic* and internally as an *expectorant*.

What is terpin and terpin hydrate? Give their use in medicine.

Terpin is a diatonic alcohol or turpentine camphor obtained by treating turpentine with alcohol and nitric acid. *Formula:* $C_{10}H_{18}(OH)_2$.

Terpin hydrate is terpin united with water. *Formula:* $C_{10}H_{18}(OH)_2H_2O$. They are used as *expectorants*.

What is camphor, chemically. Give its source and properties.

Camphor, $C_{10}H_{16}O$, is a volatile, oxidized, essential oil belonging to the class of compounds called stearoptens or camphors. It is obtained from the camphor tree. It is used as an *antispasmodic*, *carminative*, and *cardiac stimulant.*

Name some camphors used in medicine and give the source from which they are derived.

Camphor, from the camphor tree; *menthol*, from the oil of peppermint; *thymol*, from the oil of thyme; *eucalyptol*, from the oil of eucalyptus.

FERMENTATION AND PUTREFACTION

Differentiate between fermentation and putrefaction.

Fermentation is the decomposition of an organic compound into simpler, more stable substances by the action of an *enzyme* or *ferment.*

Putrefaction is the decomposition of dead nitrogenous organic substances under the action of *bacteria*, with the generation of more or less offensive odors.

Name the conditions necessary for fermentation.

The presence of a fermentiscible body, a ferment, moisture, a certain temperature, 20° to 40° C. (70° to 100° F.), and air, at least in the beginning of fermentation.

What are the chemical processes underlying fermentation and putrefaction? Give an example.

They are either hydrolytic or oxidative processes.

Example:
$$\underset{\text{Maltose.}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{Glucose.}}{2C_6H_{12}O_6}.$$

$$\underset{\text{Alcohol.}}{C_2H_5OH} + O_2 = \underset{\text{Acetic acid.}}{C_2H_4O_2} + H_2O.$$

(a) What conditions favor and (b) what conditions prevent putrefaction in dead organisms?

(a) The presence of nitrogenous substances, bacteria, a temperature of between 70° and 110° F., and moisture.

(b) The exclusion of bacteria, or air containing bacteria, and moisture; the presence of germicides; a temperature at or below the freezing-point of water.

Name and give the products of, and the name of the enzyme causing the various forms of fermentation.

1. *Alcoholic* (vinous), producing alcohol and carbon dioxid. *Enzyme:* Torula cerevisiæ (Saccharomyces).
2. *Acetous*, producing acetic acid. *Enzyme:* Mycodermæ aceti.
3. *Lactic*, producing lactic acid. *Enzyme:* Penicillium glaucum (Bacterium lacticus).
4. *Butyric*, producing butyric acid. *Enzyme:* Bacterium butyricus.
5. *Viscous*, producing gummy or ropy substances. *Enzyme* unknown.

Describe and illustrate alcoholic fermentation.

It is fermentation occurring in a solution of sugar containing the alcoholic ferment of the yeast plant, with the production of alcohol and carbon dioxid.

$$\underset{\text{Glucose.}}{C_6H_{12}O_6} = \underset{\text{Alcohol.}}{2C_2H_5OH} + 2CO_2.$$

Explain the principal action of yeast.

Under conditions necessary for fermentation, yeast causes a rearrangement of the C, H, and O atoms in the molecule of glucose, with the formation of two molecules each of alcohol and carbon dioxid.

What is acetous fermentation?

It is an advanced stage of alcoholic fermentation in which the alcohol is oxidized into acetic acid by the enzyme Mycodermæ aceti.

$$\underset{\text{Alcohol.}}{C_2H_5OH} + O_2 = \underset{\text{Acetic acid.}}{C_2H_4O_2} + H_2O.$$

What foods undergo lactic acid and butyric acid fermentation?

Carbohydrates, milk, and butter. In milk lactic acid is produced by the action of Bacterium lactis on the lactose.

$$\text{(a) } \underset{\text{Lactose.}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{Glucose.}}{2C_6H_{12}O_6}.$$

$$\text{(b) } \underset{\text{Glucose.}}{2C_6H_{12}O_6} = \underset{\text{Lactic acid.}}{4C_3H_6O_3}.$$

Butyric acid fermentation is an advanced stage of lactic acid fermentation, and takes place in milk and butter. In butter it is due to the splitting of butyrin by the fat-splitting enzyme into butyric acid and glycerin.

$$\underset{\text{Lactic acid.}}{2C_3H_6O_3} = \underset{\text{Butyric acid.}}{C_4H_8O_2} + 2CO_2 + H_2.$$

$$\underset{\text{Butyrin.}}{C_3H_5(C_4H_7O_2)_3} + 3H_2O = \underset{\text{Butyric acid.}}{3C_4H_8O_2} + \underset{\text{Glycerin.}}{C_3H_5(OH)_3}$$

Give (a) the formula, (b) sources, (c) properties, and (d) the uses of acetic acid.

(a) $HC_2H_3O_2$ or CH_3COOH.

(b) *Acetic acid* is obtained from the destructive distillation of wood and the fermentation of alcohol.

(c) It is a colorless liquid having a strong, pungent, vinegar-like odor and an acid taste. It unites with bases to form salts called *acetates*.

(d) It is used as a refrigerant, astringent, and excitant; a mild caustic for softening and removing callous tissue; a solvent, and disinfectant.

Mention (a) the most common and (b) the purest form of acetic acid, and (c) give the most important acetates.

(a) *Vinegar*, a dilute form, containing not less than 6 per cent., by weight, of acetic acid.
(b) *Glacial acetic acid*, which contains 99 per cent., by weight, of acetic acid, crystalline solid at 59° F.
(c) *Potassium acetate*, sodium acetate, lead acetate.

How may sulfuric acid be detected in vinegar (acetic acid)?

By the addition of barium chlorid, which yields a white precipitate of barium sulfate insoluble in acids.

What is vinegar, chemically? Describe the chemical changes occurring in the manufacture of vinegar.

Vinegar, see first question on this page.
Chemical changes (see page 76, third question).

ALCOHOLS

What is an alcohol?

An *alcohol* is the hydroxid of a hydrocarbon radical, as methyl alcohol, CH_3OH.

What is ethyl hydrate? Give its formula and state how it is produced. C_2H_5OH

Ethyl hydrate (ethyl hydroxid, ethyl alcohol, grain alcohol) is ordinary (common) alcohol composed of the ethyl radical united to the hydroxyl group. *Formula:* C_2H_5OH.
It is produced by the fermentation of sugars in solution.

What is the chemical designation of ordinary alcohol of commerce?

Ethyl hydroxid (see page 76, third question).

What are some of the substances from which ordinary alcohol is derived? Describe the chemical process of the preparation of alcohol.

Sugars, by fermentation; grain, as corn, oats, rye, barley, which must first undergo germination to change the starch into sugar; then fermentation, the alcohol being finally separated from the mixture by distillation.

What are the differences between common alcohol and absolute alcohol?

	Common alcohol.	Absolute alcohol.
Per cent., by weight, of water......	about 9.	Not more than 1.
Specific gravity at 15.6° C...............	0.820	0.797

Name some of the contaminations of alcohol and how they may be detected.

1. *Fusel oil*, composed largely of amyl alcohol, with other substances. No foreign odor should be perceptible when the last traces of alcohol in a mixture of 10 cc. alcohol with 5 cc. water and 1 cc. glycerin has evaporated spontaneously from a piece of clean, odorless blotting paper.

2. *Amyl alcohol:* No red or brown color should be produced on the addition of a few drops of pure, strong sulfuric acid to a dish moistened with the residue of the spontaneous evaporation of 25 cc. of alcohol.

3. *Aldehyd:* When 10 cc. of alcohol in a test-tube is mixed with 5 cc. of potassium hydroxid test solution (U. S. P.), the liquid should not at once assume a brown color (absence of aldehyd).

Name three common kinds of spirituous liquors and describe their manufacture.

Whiskey (*spiritus frumenti*) is obtained by distillation from fermented grain, as corn, rye, barley, and from potatoes.

Brandy (*spiritus vini gallici*) is distilled from wine.

Rum is distilled from fermented molasses and contains 40 to 45 per cent. of alcohol.

Name the principal alcoholic beverages obtained from the fermentation of malted grain and give their alcoholic content.

Beer contains 1.5 to 5 per cent. of alcohol; *stout*, 3 to 6 per cent.; *porter*, 5 to 7 per cent.; *ale*, 6 to 9 per cent.

How does wine differ chemically from brandy?

Wine contains more solids than brandy and some volatile ethers not contained in brandy. Wine contains from 5 to 18 to 25 per cent. of alcohol, and brandy from 45 to 55 per cent.

What percentage of alcohol is contained in whiskey?

From 44 to 55 per cent.

What is methyl alcohol? What are its properties and uses?

Methyl alcohol (wood alcohol, wood spirit), CH_3OH, is a product of the destructive distillation of wood. It is a light, colorless liquid having a characteristic, disagreeable odor, miscible with water in all proportions, and *poisonous*. Its vapor is explosive.

It is used as a solvent for fats, oils, camphor and resins; in the manufacture of varnishes and organic dyes; and for heating purposes.

ETHER

What is understood by the group of chemical substances known as the ethers?

Ethers are oxids of hydrocarbon radicals, or they may be considered after the type of water in which both atoms of hydrogen have been replaced by an alcohol radical.

Example: H O H, water,

C_2H_5 O C_2H_5, or $(C_2H_5)_2O$, ethyl ether.

How do mixed ethers differ from compound ethers? Give an example of each.

Mixed ethers are ethers containing two different radicals, as $CH_3OC_2H_5$, methyl-ethyl-ether.

Compound ethers (esters) are salts formed by the union of a hydrocarbon radical capable of producing an ether with an acid, as $C_5H_{11}NO_2$, amyl nitrite.

Describe ethyl oxid, giving the ordinary name, formula, derivation, and mode of production, with reactions occurring.

It is a transparent, colorless, mobile liquid with a characteristic odor and a burning, sweetish taste. It boils at 35° C., its vapor being very inflammable. Its ordinary name is ether, sometimes called sulfuric ether and ethyl (ethylic) ether. *Formula:* $(C_2H_5)_2O$.

It is derived from alcohol by the dehydrating action of sulfuric acid. *Production:* By distilling a mixture of alcohol and sulfuric acid at about 140° C.

$$\underset{\text{Alcohol.}}{C_2H_5OH} + H_2SO_4 = \underset{\text{Sulfovinic acid.}}{C_2H_5HSO_4} + H_2O.$$

$$C_2H_5HSO_4 + C_2H_5OH = \underset{\text{Ether.}}{(C_2H_5)_2O} + H_2SO_4.$$

From what substances is ether obtained?

Alcohol and sulfuric acid (see preceding question, Production).

CHLOROFORM

What is chloroform, chemically, and how is it made?

Chloroform (trichlormethane, formyl chlorid) is methane, CH_4, in which three atoms of hydrogen have been replaced by three atoms of chlorin, yielding $CHCl_3$. It is prepared by the action of chlorinated lime (bleaching salt of lime) on ordinary alcohol or acetone or (the purest) from chloral.

Give the composition and properties of chloroform.

Formula, $CHCl_3$.

It is a heavy, colorless, volatile liquid having a burning, sweetish taste and characteristic odor. Its specific gravity is 1.476 at 25° C. It is not inflammable, but its vapor, when heated, burns with a green flame. It boils at 60° C. It is a solvent for many substances, as fats, oils, alkaloids. It is employed in medicine as an *anesthetic*, *sedative*, and externally as a *local irritant*.

Name some of the impurities of chloroform and give tests by which they may be detected.

Alcohol: A specific gravity lower than 1.476 at 25° C. indicates too much alcohol. From 0.6 to 1 per cent. of alcohol is allowable and renders the chloroform more stable.

Chlorin: If one volume of chloroform and two volumes of water are thoroughly shaken and then allowed to separate, the watery solution upon the addition of potassium iodid yields a *yellow* color due to the liberation of iodin by the chlorin. If the watery solution is treated with silver nitrate, a milkiness or *white* precipitate of silver chlorid is produced.

Hydrochloric acid: A watery solution obtained in the manner described under chlorin turns litmus paper red; with silver nitrate the solution yields a *white* precipitate (AgCl).

Aldehyd: Chloroform, when shaken with potassium hydroxid, burns brown if aldehyd is present.

Water: Anhydrous copper sulfate added to the chloroform is dissolved if water is present, producing a *blue* color.

IODOFORM

What is the chemical name and formula of iodoform and of what is it a derivative?

Its chemical name is tri-iodomethane (formyl iodid). *Formula:* CHI_3. It is a derivative of methane, CH_4, in which three atoms of hydrogen have been replaced by three atoms of iodin.

How is iodoform prepared? Give its properties and uses in medicine.

Iodoform is prepared by boiling a solution containing potassium hydroxid, potassium iodid, iodin, and alcohol or acetone. It occurs in bright yellow, hexagonal crystals, having a penetrating, disagreeable odor. It is *in*soluble in water, but *soluble* in alcohol and ether. Iodoform is extensively used in surgical dressings for its *antiseptic* and local anesthetic properties. If used too freely it may cause poisoning from the liberation and absorption of iodin.

Define decay and give an example.

Decay is the decomposition of organic bodies by slow oxidation, without increase in the temperature. *Example:* Wood exposed to the air in the presence of moisture slowly oxidizes into CO_2 and H_2O, leaving a slight residue.

What chemical changes take place in decaying bodies?

Various gases are produced, dependent upon the composition of the decaying body, as CO_2, H_2O, NH_3 always, and H_2S or $(NH_4)_2S$ if sulfur is present; H_3P if phosphorus is present.

What are aldehyds? Give an example.

Aldehyds (dehydrogenated alcohols) are alcohols from which two atoms of hydrogen have been extracted by oxidation. *Example:* formaldehyd, HCOH, obtained by the oxidation of methyl alcohol, CH_3OH.

CHLORAL

Describe chloral. Give its formula and mode of preparation.

Chloral (trichloraldehyd) is a colorless, oily liquid with a pungent odor and acrid taste, soluble in water. *Formula:* CCl_3COH. Chloral is prepared by saturating absolute alcohol with dry chlorin, shaking the product with sulfuric acid and distilling, after which the distillate is treated with lime and again distilled.

What is formed when chloral is heated with caustic potash?

Chloroform.

Describe chloral hydrate. Give its formula, method of preparation, incompatibilities, and use in medicine.

Chloral hydrate is a colorless, crystalline compound having an aromatic, pungent odor and bitterish taste. It slowly volatilizes in the air. It is toxic. *Formula:* $CCl_3COH.H_2O$. Chloral hydrate is prepared by adding just sufficient water to chloral to form the crystals.

It is *incompatible* with alcohol, potassium iodid, camphor, phenol, thymol, and menthol. It is used in medicine as a *hypnotic*.

Give the chemical difference between chloral and chloroform.

Chloral is trichloraldehyd, obtained by the displacement of three atoms of hydrogen of the alcohol radical in aldehyd, by three atoms of chlorin.

Chloroform is trichlormethane, the result of the displacement of three atoms of hydrogen in methane by three atoms of chlorin.

Chloral, CCl_3COH.

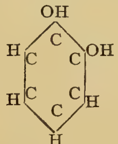
Chloroform, $CHCl_3$.

Chloral contains oxygen; chloroform does not.

PHENOLS

Give the definition and the graphic formula of a phenol.

A *phenol* is a substitution compound of benzene in which one or more atoms of hydrogen of benzene have been replaced by the hydroxyl group, (OH).



$= C_6H_4(OH)_2$, resorcin.

Give (a) the composition, (b) synonyms, (c) properties, and (d) the mode of manufacture of carbolic acid.

(a) C_6H_5OH.

(b) Phenol, hydroxybenzene, phenic acid, phenylic acid.

(c) Pure *carbolic acid* occurs in the form of colorless crystals, which are deliquescent and soluble in water, glycerin, and fixed oils. The commercial variety is a pink to dark red or brown liquid. It has an odor like that of creosote, and a burning, caustic taste. It first causes blanching of mucous membranes and finally an eschar. It has *germicidal*, *antiseptic*, and slight *local anesthetic* properties. The salts are termed "phenates," "phenylates," or "carbolates."

(d) Heavy oil of coal-tar is distilled between 165° C. and 190° C., and the distillate treated with caustic soda, which forms sodium carbolate. It is further purified, and just sufficient sulfuric acid is added to set free the carbolic acid. Carbolic acid may be obtained by the distillation of wood-tar and by various synthetic methods.

6

Give the uses of carbolic acid.

Antiseptic and *disinfectant;* it is used as a local application in diphtheria, follicular tonsillitis, stomatitis, etc.; as a *local anesthetic.* Internally, it is used as an *antiferment* in diarrhea and as a *depressant* to the sensory nerves in nervous vomiting, or in that due to gastric irritation.

What products of phenol are of interest in medicine?

Resorcin, salol, trinitrophenol (picric acid), the sulfocarbolates (phenolsulfonates), as of sodium and zinc.

What is the difference between an alcohol and a phenol?

An alcohol is the hydroxid of an alcohol radical and a phenol is the hydroxid of benzene.

A phenol in chemical character stands between the true alcohols and the organic acids.

On oxidation an alcohol yields an aldehyd and an acid; a phenol undergoes no such change.

Alcohol treated with sulfuric acid yields ether; phenol does not.

With metals both form ~~salts,~~ the phenol compounds being more stable.

Name some of the coal-tar products useful in medicine, and give the general method of manufacture of any one of them.

Carbolic acid, naphthalin (naphthalene), naphthol (naphtol), antipyrin, acetanilid (antifebrin), phenacetin, saccharin (benzosulphonidum). Method of manufacture of carbolic acid (see page 81, last question).

Mention three coal-tar products extensively used in medicine that are prepared in the chemical laboratory by synthesis.

Saccharin, phenacetin, and salicylic acid.

What is the source of phenacetin? (a) Describe its properties. (b) Give its uses in medicine.

Phenacetin is a coal-tar product prepared by the action of glacial acetic acid upon paraphenetidin.

(a) It is a white, odorless, tasteless, crystalline solid, sparingly soluble in water, readily soluble in alcohol. It is *toxic* in overdoses.

(b) It is used as an *antipyretic*, *analgesic*, and *antineuralgic.*

What is salol? (a) Give its properties. (b) Give its uses in medicine.

Salol (phenyl salicylate) is a compound composed of 60 parts of salicylic acid and 40 parts of carbolic acid, prepared by heating salicylic acid in an atmosphere of CO_2, or by dehydrating a mixture of salicylic acid and carbolic acid.

(a) It is a white, faintly aromatic, crystalline powder; nearly insoluble in water, readily soluble in alcohol, ether, chloroform, and fatty oils. It is *toxic* in overdoses.

(b) *Antirheumatic*, *antipyretic*, and *intestinal antiseptic.* It passes through the stomach unchanged and is broken up in the intestines into phenol and salicylic acid by the action of the pancreatic juice.

PETROLEUM

What is petroleum (coal oil)? What important derivatives of petroleum are used in medicine?

Petroleum or coal oil is the product of the decomposition of the remains of fish and other sea animals deposited in the earth. It is a mixture of various compounds, chiefly of the methane series, as paraffins.

Its derivatives used in medicine are: *petrolatum* (petrolatum molle, petrolatum spissum, known by the trade names of *cosmolin, vaselin,* etc.); petrolatum album; petrolatum liquidum.

What is the source, principal properties, and uses in medicine of vaselin?

Vaselin is obtained from petroleum by distilling off the lighter and more volatile portion and purifying the residue. It is a fat-like mass, of a white to yellowish color, having a slight fluorescence, tasteless, and odorless, but when heated giving off a faint petroleum-like odor. It is used for its protective properties in dressing sores, in skin affections, and as a base for ointments. Internally, it is used for its soothing effect in gastro-intestinal irritation.

To what class of organic compounds does glycerin belong? Give its formula. Where does glycerin exist in nature, and from what source is it obtained?

Glycerin is a triatomic alcohol. *Formula:* $C_3H_5(OH)_3$. It exists in combination in fats, being the basic part of the fat. It is obtained by the action of superheated steam, an alkali, or an enzyme upon fats, thus causing a splitting of the fat into fatty acid and glycerin.

What is the chemical designation and formula of nitro-glycerin? How is it manufactured? Give its medical properties and the form in which it is used.

Trinitroglycerin (glonoin, trinitrin, glyceryl trinitrate). *Formula:* $C_3H_5(NO_2)_3O_3$.

Nitroglycerin is prepared by gradually mixing glycerin with nitric and sulfuric acids, three atoms of hydrogen in the glycerin being replaced by three nitro (NO_2) groups. It separates as a heavy, oily substance, which is washed with water and dried. It is a rapid, powerful *cardiac stimulant* and *vasomotor depressant.* It is used in the form of pill and as an alcoholic solution containing 1 per cent. by weight of nitroglycerin, termed spiritus glycerylis nitratis (*spiritus glonoini*).

What is gun-cotton? (a) What preparation of gun-cotton is used in medicine, and (b) what is its solvent?

Gun-cotton is trinitrocellulose, $C_6H_7(NO_2)_3O_5$, obtained by treating cotton (cellulose) with nitric and sulfuric acids. This product is highly explosive and insoluble.

(a) The U. S. P. gun-cotton (pyroxylinum) is a product obtained in the same way, consisting chiefly of dinitrocellulose (cellulose dinitrate), $C_6H_8(NO_2)_2O_5$, and is soluble.

(b) Soluble in a mixture of one volume of alcohol and three volumes of ether.

How is collodion prepared and what are its uses?

Pyroxylin, 4 gm.; ether, 75 cc.; alcohol, 25 cc.

The ether is added to the pyroxylin in a suitable vessel and allowed to stand fifteen minutes; then the alcohol is added and the mixture shaken until the pyroxylin is dissolved. It is used as a *protective* to the abraded skin and as a basis for photographic sensitized films.

(a) What is the formula and source of tartaric acid? (b) What is its use in medicine? (c) What double salts of this acid are used in medicine?

(a) $H_2C_4H_4O_6$. *Tartaric acid* is a constituent of many plants and fruits, especially grapes, and is obtained from the deposit, (argols, crude tartar, which is impure potassium bitartrate), occurring in the fermentation of wine.

(b) It is a heat-reducing agent, but rarely used alone. It is used in conjunction with sodium bicarbonate in the preparation of effervescent salts or mixtures, as *Seidlitz powder.*

(c) *Potassium sodium tartrate* (Rochelle salt), $KNaC_4H_4O_6$; *antimony potassium tartrate* (tartar emetic), $2K(SbO)C_4H_4O_6+H_2O$.

Give the formula, occurrence in nature, and source of (a) citric acid, (b) oxalic acid, (c) lactic acid, and (d) benzoic acid.

(a) $H_3C_6H_5O_7+H_2O$. *Citric acid* occurs free in lemons, currants, raspberries, cranberries, and gooseberries, and is obtained mostly from lemon-juice.

(b) $H_2C_2O_4+2H_2O$. *Oxalic acid* is present in many plants, as dock and sorrel, in the form of the potassium salt; in rhubarb, beets, etc., as the calcium salt. It also occurs in the urine of man as a salt under certain conditions. It is obtained from rhubarb, but mostly prepared artificially from sugar by the action of nitric acid or from sawdust by the action of caustic soda.

(c) $C_3H_6O_3$. *Lactic acid* is found in opium, ensilage, sauerkraut, gastric juice, sour milk, koumiss, and as sarcolactic or paralactic acid in muscle, extract of beef, blood, and sometimes in urine. It is produced by the fermentation of sugar.

(d) $HC_7H_5O_2$. *Benzoic acid* is present in gum benzoin and the urine of herbivora. It is obtained from benzoin, but is chiefly prepared artificially.

What organic acids are present in vegetables and fruits?

Tartaric, citric, oxalic, malic, tannic, etc.

ALKALOIDS

Define an alkaloid and (a) name three principal ones used in medicine.

An alkaloid is a nitrogenous organic basic principle of vegetable or animal origin, giving, in most instances, to the body from which it is derived, its characteristic physiologic properties.

(a) Quinin, strychnin, and morphin.

What elements enter into the composition of all alkaloids?

Carbon, hydrogen, and nitrogen in volatile or liquid alkaloids, as coniin, nicotin, spartein. Carbon, hydrogen, nitrogen, and oxygen in fixed or solid alkaloids, as morphin, strychnin.

Give the general properties of alkaloids.

They are liquids or solids, having basic properties and many reactions like ammonia, combining directly with acids, without the displacement of hydrogen-forming salts. Most of them are crystalline, white, with a bitter taste, and odorless, except those which are volatile. They are insoluble in alkalies, only sparingly soluble in water, but readily soluble in alcohol, ether, chloroform, benzene, petroleum ether, and amylic alcohol. They are all more or less toxic.

Name five alkaloids, giving the derivation of each.

Strychnin from nux vomica; *morphin* from opium; *atropin* from belladonna; *quinin* from cinchona bark; *cocain* from erythroxylon coca.

State the effect of alkalies on alkaloids in solution.

They are precipitated in the form of the alkaloids.

What general methods may be employed to distinguish the common alkaloids from each other?

1. Their physical properties, as color, odor, taste, and solubility.
2. Their chemical reactions with certain reagents.
3. Their physiologic action (most important).

Give two tests for quinin in solution.

1. Quinin solution acidulated with sulfuric acid yields a *blue fluorescence*.

2. *Thalleioquin Test:* Solution of quinin with chlorin or bromin water, treated with an excess of ammonium hydroxid, produces an *emerald green* color, due to thalleioquin.

How may quinin be distinguished from all other alkaloids of cinchona?

1. *Herapathit Test:* One half gram of alkaloid is dissolved in 15 cc. of alcohol of 0.83 specific gravity, diluted with 5 cc. of water, and acidulated with 2 cc. of 10 per cent. H_2SO_4. To this solution is added 0.2 gram of iodin in 10 cc. of 0.83 specific gravity alcohol, and the mixture warmed slightly and allowed to cool. An insoluble microcrystalline precipitate of *dark green*=quinin; *red*=quinidin; *yellow*=cinchonidin; *no precipitate*=cinchonin.

2. The thalleioquin test (see preceding question, 2) distinguishes quinin from all cinchona alkaloids except quinidin and quinicin.

TOXICOLOGY

What is a poison?

A poison is any substance producing deleterious effects upon the animal organism. The poison may be (1) taken into the body and *absorbed;* (2) it may act directly on the parts with which it comes in contact—*direct chemical action;* (3) it may be applied *externally*, and *enter the circulation.*

How may poisons be classified? Give the manner of action of each class.

Irritant poisons produce irritation and inflammation of the stomach and intestines, attended or followed by intense pain in these parts, tenderness of the abdomen, and violent vomiting and purging, the material evacuated being often tinged with blood. They may be of *mineral*, *vegetable*, or *animal* origin.

Narcotic or *cerebral* poisons act principally on the brain and spinal cord, more especially on the former. They induce headache, vertigo, stupor, visual disturbance, delirium, insensibility, paralysis, convulsions, and coma.

Narcotico-irritant poisons partake of the action of both the irritant and narcotic poisons.

Give an example of (a) irritant, (b) narcotic, and (c) narcotico-irritant poisons.

(a) *Arsenic*, from mineral; *gamboge*, from vegetable; *cantharides*, from animal.

(b) Opium and hydrocyanic acid.

(c) Strychnin and brucin.

What are the evidences of poisoning?

1. The symptoms.
2. The post-mortem appearances.
3. The results of a chemical analysis of various organs, as the stomach, intestines, liver, and kidneys.

How would you conduct an autopsy for the purpose of testing for arsenic in the stomach, intestines, and tissues?

The cardiac and pyloric ends of the stomach and the rectal end of the intestines, or any portion desired to be removed, after being ligated in two places, just sufficiently separated to permit cutting between them, are severed, and the stomach and intestines with their contents placed *separately* into clean glass jars, hermetically sealed with some special imprint upon the seal, in such a manner that the jars cannot be opened without breaking the seal and imprint. In the same careful manner at least one kidney, the spleen, at least a portion of the liver, and the brain are removed, placed into separate clean jars, and sealed in the same manner as the stomach and intestines. Then all are properly labeled and retained until delivered to the proper official.

All appearances of each of the organs taken, abnormal or otherwise, are fully written down at the time of observation, having the assistance and corroboration of another physician, and, if possible, in the presence of the proper official.

Mention the metals whose salts are often taken as poisons.

Arsenic, mercury, antimony, lead, silver, copper, and zinc.

Mention the antidote applicable in a case of poisoning from silver nitrate. How does the antidote act?

Common table salt, *sodium chlorid*.

It produces insoluble silver chlorid, which is non-toxic.

Give the antidotes applicable in cases of poisoning with zinc chlorid.

Albumin, tannic acid, strong tea, and sodium bicarbonate.

What is the chemical antidote in cases of poisoning with (a) corrosive sublimate, and (b) tartar emetic?

(a) Albumin (egg) in large quantity, speedily followed by an emetic or the removal of the resulting compound with the stomach-pump.

(b) Tannic acid.

Upon what theory are eggs given in cases of poisoning with corrosive sublimate?

Upon the theory that the albumin of the eggs forms an insoluble albuminate of mercury.

What are the antidotes for poisoning with (a) copper sulfate, (b) oxalic acid?

(a) Potassium ferrocyanid, and albumin.

(b) Lime-water or preferably chalk; magnesium oxid or carbonate.

Name the chemical antidotes for poisoning with (a) mineral acids, and (b) caustic alkalies.

(a) Magnesium oxid, chalk, lime, soap, and albumin.

(b) Fats or oils; vinegar or acetic acid well diluted with water; lemon-juice (citric acid).

(a) State the most common and convenient antidotes for poisoning with mineral acids. (b) State the course to be pursued when the poison to be antidoted is unknown.

(a) Magnesium oxid; alkaline carbonates, as sodium bicarbonate; chalk, soap; these to be followed with fats, oils, eggs, milk, and flour.

(b) Produce emesis with mustard, zinc sulfate, or apomorphin hydrochlorid hypodermically, or empty the stomach with the stomach-pump or siphon tube. If an alkaloidal poison is suspected, give tannic acid or permanganate of potassium. Thoroughly wash out the stomach with a mucilaginous solution or sodium bicarbonate. Apply artificial heat to the body, stimulate with ammonia, whiskey, strong coffee, and treat the symptoms as they arise.

Mention a chemical antidote for sulfuric acid and explain the action of this antidote.

Magnesium oxid. It neutralizes the sulfuric acid with the formation of magnesium sulfate and water, accompanied by the evolution of but little heat and no gas.

What are the antidotes for nitric acid and hydrochloric acid poisoning?

Magnesium oxid (calcined magnesium), alkaline carbonates, soap, oils, and albumin.

Mention the antidotes applicable in a case of poisoning from iodin.

Starch, demulcent drinks of flaxseed tea, elm bark; or gruel, milk, and white of egg.

What antidotes should be used in phosphorus poisoning? Explain the action of each.

Copper sulfate in solution. It quickly coats the phosphorus with a black deposit, said to be copper phosfid, which is insoluble in the digestive fluids.

Turpentine, preferably the French variety, which is old and has become ozonized. It produces some oxidative product of phosphorus which is non-poisonous or comparatively free from toxic action.

What is the antidote for poisoning with hydrocyanic acid?

Freshly precipitated *hydrated ferric oxid*, or ferric hydroxid with magnesium oxid, which forms Prussian blue, an inert substance. Inhalation of ammonia or chlorin, with cold effusions to the face, should always be employed with the iron compound.

What is the chemical treatment for carbolic-acid poisoning?

The chemical antidote is any *soluble, non-poisonous sulfate*, as Epsom salt (magnesium sulfate), sodium sulfate, or potassium sulfate. As these act only upon the carbolic acid in the blood, forming non-toxic phenol-sulfates (sulfocarbolates), the chemical antidote should be preceded by the free use of alcohol, which allays the irritation, and the stomach rapidly emptied by administering a hypodermic injection of apomorphin hydrochlorid.

What is the treatment for creosote poisoning?

The same as for carbolic acid (see preceding question).

Name five common vegetable poisons and give the antidote for one of them.

Opium, belladonna, nux vomica, digitalis, and aconite.

Opium: Antidote, potassium permanganate; *atropin*, caffein.

Give the (a) chemical, and (b) physiologic antidote for morphin and strychnin.

(a) Morphin: potassium permanganate, tannic acid. Strychnin: tannic acid, iodin with potassium iodid.

(b) Morphin: atropin or tincture belladonna, caffein (coffee). Strychnin: chloral, potassium bromid.

How would you treat a case of poisoning by (a) morphin, and (b) strychnin?

Give successive portions of potassium permanganate solution (1 to 2 gr. to the pint of water) and then—

(a) Empty the stomach by siphon or emetics, as mustard (4ʒ to 1℥

water), zinc sulfate (20 gr. to 1℥ water), or a hypodermic injection of apomorphin hydrochlorid (8 to 10 min. of a 2 per cent. solution). Administer strong coffee copiously, and, if necessary, hypodermic injections of $\frac{1}{100}$ gr. to $\frac{1}{50}$ gr. of atropin, keeping the patient awake by walking, shaking, or striking with a towel, and applying cold water to the face and chest. Stimulate the circulation by inhalation of amyl nitrite. If the respiration becomes embarrassed institute artificial respiration.

(b) Administer an emetic and tannic acid (20 to 30 gr.), or iodin (1 to 2 gr.) with potassium iodid (5 to 10 gr.), in 1 oz. of water. Convulsions are controlled with inhalations of chloroform or with 1-dr. doses of potassium bromid or $\frac{1}{2}$-dr. doses of chloral hydrate. If necessary, give the chloral hydrate by rectum. The patient must be kept in a dark, quiet place.

Give two tests for morphin.

Sulfomolybdic acid test (Frohde): On addition of a drop of sulfomolybdic acid to morphin, or any of its salts in the solid state, a *purple* or *crimson* color is immediately produced, which passes through various shades and finally to *blue*, appearing first at the margin of the mixture.

Neutral ferric chlorid added to morphin or any of its salts in the solid state produces a *deep blue color.*

Give a method to be employed in proving the presence of opium in the contents of the stomach in a case of poisoning.

If the mass contains very little liquid, mix thoroughly with distilled water and filter. Treat the filtrate with lead acetate, which precipitates lead meconate, and the precipitate collect on a filter and wash with water. The filtrate, which contains morphin, etc., is concentrated and tested for morphin with nitric acid, which yields an *orange-red* color, and with the sulfomolybdic acid and ferric chlorid tests, for which see preceding question.

The precipitate of lead meconate is suspended in water and treated with hydrogen sulfid until all the lead is precipitated and filtered. The filtrate is evaporated to a small volume and tested for meconic acid with ferric chlorid, which yields a *blood-red* color. (Meconic acid is the characteristic acid of opium, and should always be sought for in cases of suspected opium poisoning.)

Give the formula for strychnin and describe a test for detecting its presence.

Formula: $C_{21}H_{22}N_2O_2$.

Color test: When strychnin or one of its salts is dissolved in a drop of strong, chemically pure sulfuric acid on a porcelain test tablet, and a minute fragment of a crystal of potassium dichromate drawn through the solution by means of a glass rod, an immediate play of colors—*blue, purple, violet,* and *greenish-yellow*—is produced.

Name the antidotes in a case of poisoning from (a) stramonium, (b) strophanthus.

(a) Tannic acid, morphin, caffein, and pilocarpin.
(b) Tannic acid, aconite, and morphin.

Give the source, character, and uses of atropin. Describe the symptoms of poisoning by atropin and name its antidotes.

Atropin is derived from belladonna. It is a colorless, crystalline solid, having a bitter acrid taste, insoluble in water, freely soluble in alcohol, chloroform, and ether, and highly toxic.

Uses: It is used as a *mydriatic* and a *cardiac* and *respiratory stimulant.*

Symptoms: Dryness of throat and mouth, difficult deglutition, dilatation of the pupils, impaired vision, and delirium, succeeded by drowsiness and stupor. The pulse is at first slow and hard, later soft, dicrotic, and rapid.

Antidotes: Morphin, pilocarpin, and tannic acid.

What is uremic poisoning and how is it treated?

An auto-intoxication caused by the non-elimination, with the consequent absorption, of effete toxins formed in the metabolic processes. It is treated by aiding the elimination of the poisons through the bowels, skin, and kidneys. This is accomplished by first catheterizing, giving $\frac{1}{8}$ gr. of apomorphin hydrochlorid hypodermically, and internally $\frac{1}{16}$ to $\frac{1}{6}$ gr. of elaterium or saturated solution of magnesium sulfate, and, if necessary, applying heat by means of a hot pack or hot-air bath. The heart and respiratory organs are stimulated with strychnin and atropin, as required.

How do chemical and physiologic antidotes differ in their actions? Illustrate each.

A *chemical antidote* produces an insoluble or non-toxic substance with the poisonous substance. *Example:* Magnesium sulfate is an antidote for soluble salts of lead, as it forms insoluble lead sulfate, thus preventing the absorption of lead.

A *physiologic* antidote does not act directly upon the toxic body, but produces physiologic effects opposed to those occasioned by the poisonous substance. *Example:* Atropin is the physiologic antidote to morphin, as it stimulates the respiratory organs which are depressed by the action of the morphin.

How do corrosive poisons differ from true poisons?

Corrosive poisons are mostly inorganic bodies which produce irritation, inflammation, and more or less disorganization of the parts with which they come in contact, as strong acids and alkalies. *True poisons* are those substances which enter the circulation and act principally on the brain and spinal cord, as morphin or strychnin.

What is the difference between ptomains and leukomains?

Ptomains (ptomatins) are basic organic compounds, resembling vegetable alkaloids, and produced by the action of bacteria on nitrogenous matter. They are either toxic (toxins) or non-toxic. *Examples:* Cadaverin, tyrotoxin, tyrotoxicon, and typotoxin.

Leukomains are basic organic substances resulting from metabolism (retrograde metamorphosis) in the body. *Examples:* cerebrin, creatinin, and creatin.

Ptomains and leukomains are known as *animal alkaloids.*

What is the chemical treatment of esophageal and stomach corrosion from mineral acids? Give an argument against the use of the stomach-pump in such cases.

Neutralize the acids by the use of magnesium oxid, and lubricate and allay the irritation of the parts with albumin (white of egg) and oils.

By the action of the acids the tissues become more or less disintegrated and readily perforated, especially the esophagus, by the introduction of a stomach-pump or tube, with fatal results.

Physiologic Chemistry

Define physiologic chemistry.

Physiologic chemistry is the study of the chemical properties of the tissues, the secretions and excretions of the body, and of foodstuffs, the chemical changes which occur in their transformation into living tissue, and their ultimate fate.

Name the principal substances composing the human body.

Inorganic { Water, Mineral substances: calcium phosphate, calcium carbonate, etc.

Organic { Non-nitrogenous compounds: carbohydrates and fats. Nitrogenous compounds: albumins and hemoglobin.

Define the terms metabolism, catabolism, and anabolism.

Metabolism embraces the various chemical changes occurring in the living body, due to the action of enzymes, bacteria, and the living cell activity.

Catabolism (*destructive* or *analytic* metabolism) is the process which changes complex bodies into simpler ones, as occurs in the digestive and respiratory processes.

Anabolism (*constructive* or *synthetic* metabolism) is the process which builds up more complex bodies from simpler ones, as occurs in the construction of tissues by the living cells from the absorbed digestive products.

What is an anesthetic? Give the name, formula, and properties of one.

A substance which produces insensibility to feeling or to acute pain, diminished muscular action, and partial or complete unconsciousness. It may be general or local in its effects.

Ether $(C_2H_5)_2O$, produces unconsciousness, muscular relaxation, insensibility to pain, and, in over dose, death from paralysis of the nerve centers controlling respiration.

Give the names and formulas of the various gaseous compounds capable of producing general anesthesia.

Hyponitrous oxid (*nitrous oxid*, laughing gas), N_2O.
Ether $(C_2H_5)_2O$.
Chloroform, $CHCl_3$.
Ethyl chlorid (ethylene chlorid), C_2H_5Cl.

Name some substances commonly employed for the production of local anesthesia.

Cocain and *ethyl chlorid.*

What is the chemical difference between inspired and expired air?

Inspired air contains all the constituents of the normal atmosphere, as O, N, H_2O, CO_2 (0.03 per cent.), etc. *Expired* air contains no oxygen or only a very little, N, NH_3, H_2O, CO_2, the latter in much larger quantity (over 4 per cent.) than is present in the inspired air, with other gaseous products of metabolism.

How do candles and gas lights compare with human beings in regard to the quantity of oxygen they consume, and of carbon dioxid they produce?

They require more oxygen and produce more carbon dioxid than man. A burner of illuminating gas consumes about ten times as much air, and produces about six times as much carbon dioxid as a man.

Where is oxygen found in the human body, and what are its important uses in the animal economy?

Oxygen is a constituent of water, hence it is present in all animal tissues and fluids. It is present in many inorganic and organic compounds, as calcium phosphate, albumin, hemoglobin, and in the various tissues. Oxygen is absolutely necessary for respiration and all metabolic processes.

Define and illustrate osmose (osmosis).

Osmose (impulse) is the force by which liquids are driven through a moist membrane or other porous septum in endosmotic and exosmotic actions.

Example: When a dialyzer containing alcohol is suspended in water, the liquids pass through the porous septum and intermingle. More molecules of water pass into the alcohol (endosmose) than of alcohol into the water (exosmose).

What is a semipermeable membrane? Give an example.

It is a membrane permeable to liquids, but not to the dissolved solids. *Example:* When red blood-corpuscles are suspended in water, the water passes through the cell membrane into the corpuscles, but the solids of the corpuscles do not pass out into the water. The corpuscles swell and finally rupture, a process which is known as *laking*.

Define isotonic, hypoisotonic, and hyperisotonic solutions.

Isotonic. Solutions having equal molecular concentration of the solids present. *Example:* A 0.9 per cent. solution of sodium chlorid is isotonic with human blood.

Hypoisotonic (*hypotonic*). Solutions of less concentration than an isotonic solution.

Hyperisotonic (*hypertonic*). Solutions of greater concentration than an isotonic solution.

What is the strength of physiologic salt solution?

A solution containing 0.9 per cent. of sodium chlorid.

What is the normal chemical reaction of (a) saliva, (b) gastric juice, (c) pancreatic juice, (d) blood, (e) bile, (f) tears, and (g) urine?

(a) Slightly alkaline; (b) acid; (c) alkaline; (d) alkaline; (e) alkaline; (f) neutral; and (g) acid.

Mention the acid constituents of (a) gastric juice, (b) urine, and (c) bile.

(a) Hydrochloric acid. (b) Sodium acid phosphate. (c) Taurocholic and glycocholic acids in the form of their sodium salts.

What metallic chemical elements are found in the body in various combinations?

Calcium, magnesium, potassium, sodium, iron, hydrogen, and the radical ammonium.

What chemical changes take place in the body after death?

The various tissues undergo decomposition by oxidation, hydrolysis, and putrefaction. The nitrogen unites with hydrogen to form NH_3; hydrogen and sulfur split from their compounds to form hydrogen sulfid gas; carbon is given off as CO_2, CH_4, and other gases; phosphorus is separated from the bones and other tissues, forming phosphoric acid and hydrogen phosphid; many ptomains and other compounds are produced, and finally a dry residue remains.

Name some of the phosphates contained in the human body.

The phosphates of the alkali metals (alkaline phosphates), as sodium, potassium, and ammonium phosphates; the phosphates of the alkali earth metals (earthy phosphates), as calcium and magnesium phosphates, and glycerin phosphoric acid in lecithin.

How are the phosphates produced in the animal body?

The phosphates which exist, preformed, in vegetable and animal foods, when ingested, are absorbed as such by the animal body. The phosphorus, when ingested in other forms, undergoes oxidation, and the oxid formed becomes hydrated into phosphoric acid, which produces a phosphate.

UREA

Give (a) the chemical formula, (b) the molecular weight, and (c) the quantity by weight and volume of nitrogen in the molecule of urea.

(a) $CO(NH_2)_2$. (b) 60. (c) 28 gm. or 22,320 c.c.

How does urea originate in the body? In what morbid conditions is the amount of urea diminished, and in what increased?

Urea is produced by the metabolic processes from the albuminous foods ingested and from the albuminous substances in the body; it is the most important end-product of metabolism. Urea is *diminished* in diseases of the liver, as yellow atrophy, carcinoma, Weil's disease, and cirrhosis; and *increased* in diabetes mellitus and in diseases accompanied by high fever, as typhoid fever and pneumonia.

(a) In what principal form is nitrogen eliminated from the body? (b) Where is it formed in the body?

(a) Urea. (b) Liver.

How does diet affect the elimination of urea?

The elimination of urea is increased by a nitrogenous diet and diminished by a non-nitrogenous (carbohydrates and fats) or restricted diet, or starvation.

What is the principal source of urea in the human economy?

The oxidation of the nitrogenous tissues of the body, particularly muscular tissues, and the proteids ingested, after they have served their purpose in the economy.

How would you distinguish chemically between uric acid and urea?

Uric acid, when treated with a few drops of nitric acid, evaporated to dryness on a water-bath and cooled, yields a beautiful *red* color of murexid when a drop of ammonium hydroxid is added. This is called the *murexid test.* Urea with nitric acid forms crystals of urea nitrate.

Urea heated between 150° to 170° C. yields ammonia and biuret. The biuret in solution in water produces a *violet-red* color on the addition of a few drops of 2 per cent. copper sulfate solution and sufficient sodium hydroxid to render the mixture distinctly alkaline (*biuret reaction*). Uric acid does not yield the biuret reaction.

URIC ACID AND XANTHINS

What is the source of uric acid in the human economy? Give (a) the formula and properties of uric acid, and (b) a chemical test.

Uric acid is derived from the albumins of the tissues and from ingested food, especially substances containing *nucleoproteids.*

(a) $C_5H_4N_4O_3$. It is the trioxid of purin.

Uric acid, or *lithic acid*, when pure, is a colorless crystalline compound, soluble in 16,000 parts of cold and 2000 parts of hot water. Insoluble in alcohol, ether, and hydrochloric acid. Soluble in sulfuric acid and in alkaline solution, with which it forms salts. It is dibasic; forms neutral and acid salts.

(b) *Murexid Test:* See fourth question on this page.

What are xanthin bases? Name some.

Xanthin (*purin*, *alloxuric*, *nucleinic*) bases are the basic substances of nucleins (nucleoproteids), found widely distributed in the animal and vegetable world. They occur free or as constituents of nucleinic acids and nucleins, such as adenin, hypoxanthin, guanin, and xanthin.

What is the chemical purpose of administering lithium compounds in diseases attended with excessive formation of uric acid?

To combine with the uric acid and form *lithium urate*, which is soluble and readily eliminated in the urine.

What foods are contra-indicated in the lithemic diathesis, and (a) why?

Foods composed largely of cells containing the nucleoproteids, as liver, all forms of sweetbread, as pancreas, brain, etc.

(a) Because the nucleoproteids produce uric acid in the metabolic processes, which, in excess, is believed to be the cause of gout, rheumatism, and allied diseases.

Show the chemical relation of uric acid with nucleins (nucleoproteids).

Nucleoproteid

Proteid Nuclein

Proteid Nucleinic acid

Phosphoric acid Nuclein or xanthin, alloxuric or purin bases.

The purin, $C_5N_4H_4$, under oxidative processes yields:
Hypoxanthin (oxypurin), $C_5N_4H_4O$.
Xanthin (dioxypurin), $C_5N_4H_4O_2$.
Uric acid (trioxypurin), $C_5N_4H_4O_3$.

CARBOHYDRATES

Define a carbohydrate and a hydrocarbon, giving an example of each.

A *carbohydrate* is an organic compound composed of carbon, hydrogen, and oxygen, the hydrogen and oxygen being present in the same relative atomic proportion as in water. *Example:* Glucose ($C_6H_{12}O_6$).

There are other compounds composed of these three elements, in which the hydrogen and oxygen are present in the proportion to form water, but are not carbohydrates, such as acetic acid ($C_2H_4O_2$) and lactic acid ($C_3H_6O_3$).

A *hydrocarbon* is an organic compound composed of carbon and hydrogen. *Example:* Methane (CH_4).

Name the groups into which the carbohydrates are divided, and give an example of each.

The carbohydrates are divided into three chief groups, namely:

Monosaccharids (hexoses, monoses, glucoses). *Example:* Glucose ($C_6H_{12}O_6$).

Disaccharids (hexobioses, saccharoses). *Example:* Cane-sugar ($C_{12}H_{22}O_{11}$).

Polysaccharids (hexopolyoses, amyloses). *Example:* Starch ($C_6H_{10}O_5$).

Define and describe sugars. How do glucoses differ from saccharoses? What kind of sugar is found in diabetic urine?

Sugars are organic compounds called carbohydrates. They are composed of C, H, and O, the H and O being present in the proportions in which water is formed. They occur in vegetable and animal bodies and have a sweet taste.

Glucoses have the formula $C_6H_{12}O_6$; they crystallize with difficulty and have but slight sweetening power; some undergo fermentation with the production of CO_2 and alcohol. They are soluble in water. They reduce alkaline solutions of cupric hydroxid (hydrate) to cuprous oxid. Glucose polarizes light toward the right.

Saccharoses have the formula $C_{12}H_{22}O_{11}$, readily crystallize, and possess a greater sweetening power than glucoses. They are soluble in water. They do not undergo fermentation until they have been inverted into invert sugar. They do not reduce alkaline solutions of cupric hydroxid to cuprous oxid; polarize light toward the right.

Glucose is the sugar found in diabetic urine.

Name three substances usually classed as sugars and give a test for each.

Glucose, saccharose, and lactose.

Glucose and lactose reduce Fehling's solution; saccharose does not.

Saccharose boiled with a little dilute hydrochloric acid yields glucose, which, when neutralized with sodium hydroxid upon the application of Fehling's test, produces red cuprous oxid.

Differentiate chemically sucrose, lactose, maltose, and glucose.

Sucrose (saccharose, cane-sugar) has the formula $C_{12}H_{22}O_{11}$; when hydrolyzed it yields one molecule of dextrose ($C_6H_{12}O_6$) and one molecule of levulose ($C_6H_{12}O_6$). It does not reduce alkaline solutions of cupric salts.

Lactose (sugar of milk) has the formula $C_{12}H_{22}O_{11}+H_2O$, (containing a molecule of water of crystallization); by hydrolysis produces one molecule of dextrose ($C_6H_{12}O_6$) and one molecule of galactose ($C_6H_{12}O_6$). It reduces cupric salts.

Maltose (malt sugar) has the formula of $C_{12}H_{22}O_{11}+H_2O$, containing a molecule of water of crystallization; by hydrolysis it yields two molecules of dextrose ($C_6H_{12}O_6$). It reduces cupric salts.

Glucose (dextrose, grape-sugar) has the formula of $C_6H_{12}O_6$. It reduces cupric salts.

They all turn the rays of polarized light toward the right.

What is glycogen? From what is it derived? What is it converted into by dilute acids?

Glycogen (animal starch) $(C_6H_{10}O_5)_n$ is a carbohydrate (polysaccharid) closely related to starch and dextrin. It is an amorphous, white, tasteless, and odorless powder which dissolves in water, forming an opalescent solution. Glycoyen is derived from carbohydrates and some proteid foods (glucoproteids). It is stored up in the liver and is also found in the muscles. From the liver it may readily be extracted with hot water. It is converted into glucose by dilute acids.

What chemical change occurs in the making of malt?

The starch present in the grain in the process of malting is hydrolyzed into *maltose*, as shown by the following equation:

$$\underset{\text{Starch.}}{2C_6H_{10}O_5}+H_2O=\underset{\text{Maltose.}}{C_{12}H_{22}O_{11}}.$$

What are the properties and uses of glucose? State its importance in medical chemistry.

Glucose is a white or yellowish-white crystalline solid, having a sweet taste and freely soluble in water. As found in commerce it is usually a colorless or faintly yellowish, syrupy liquid, in which form it is very impure. It polarizes light toward the right, reduces cupric salts, and with yeast ferments into carbon dioxid and alcohol. It is used as a substitute for cane-sugar, as in the manufacture of candy and artificial honey. It is the final product of the digestion of carbohydrates and is present in the urine in diabetes mellitus.

Describe two tests for glucose.

Fehling's Test: Take 1 c.c. of Fehling's solution diluted with about 4 c.c. of water and boil; when glucose in solution is added and the mixture again boiled, a *yellow* precipitate of cuprous hydroxid, or a *red* precipitate of cuprous oxid is formed.

Nylander's Test: About 10 c.c. of a solution of glucose mixed with about 1 c.c. of Nylander's reagent (bismuth subnitrate, 2 parts; Rochelle salt, 4 parts; and caustic soda, 8 per cent. solution, 100 parts) and boiled, yields a *grayish-brown* to *black* color.

Give the chemical meaning of the term sugar.

Sugar is a generic name applied to all carbohydrates possessing sweetening power.

What is (a) starch, (b) dextrin, and (c) how are they converted into grape-sugar?

(a) *Starch—amylum* $(C_6H_{10}O_5)_n$—is a white, odorless, and tasteless powder, consisting of small granules which have a stratified structure, and vary in shape and size in different plants. It is *insoluble* in cold water. When boiled in water the granules swell and burst, and a homogeneous white paste is formed.

(b) *Dextrin* (British gum) $(C_6H_{10}O_5)_n$ is an amorphous, white or yellowish powder having a slightly sweetish taste and readily *soluble* in water. Its concentrated solution is viscid and sticky, similar to gum solutions.

Both starch and dextrin are carbohydrates and belong to the polysaccharid group.

(c) They are converted into grape-sugar (glucose) by the action of ptyalin, amylopsin (amylase), or dilute mineral acids.

How is starch obtained? (a) How may starch be recognized chemically? (b) What substance is formed when diastase, ptyalin, amylopsin (amylase), or dilute acids act upon starch?

Starch may be obtained by macerating potatoes and then washing out the starch with cold water.

(a) Starch yields with iodin solution a *blue* color.

(b) It is changed into glucose.

Distinguish between starch and sugar. (a) By what histologic element is starch converted into sugar?

Starch, see fourth question on this page.

Sugar (cane-sugar) C_{12}, $H_{22}O_{11}$, is a colorless, odorless, sweet crystalline solid. It is very soluble in water. Its solutions rotate polarized light toward the right. It yields no color with iodin.

(a) By *ptyalin* (ptyalase) and *amylopsin* (amylase).

Differentiate grape-sugar and cane-sugar. (a) How is the latter converted into the former?

Grape-sugar (glucose), see page 96, top, glucose.

Cane-sugar, see preceding question.

(a) By the action of ptyalin, amylopsin, or dilute mineral acids under favorable conditions it is hydrolyzed into glucose.

Give the gross chemistry of the sugars.

See Sugars, page 95, last question.

Mention several tests for sugar.

Fehling's, Trommer's, Nylander's, fermentation, phenylhydrazin, and polarizing saccharimeter.

Describe Trommer's test for sugar.

To a test-tube half filled with the solution of sugar one-fourth its volume of NaOH is added, and then copper sulfate, drop by drop, shaking after each addition until the *blue* precipitate of cupric hydroxid formed is no longer dissolved. The mixture is then boiled. The cupric hydroxid is reduced to *yellow* cuprous hydroxid or *red* cuprous oxid.

Give the chemical reason why diabetics should abstain from starchy foods.

Because starchy foods in the digestive processes form sugar, which the lowered metabolic activity of the body in diabetes is incapable of transforming into energy, with the consequent circulation in the blood and elimination of the sugar in the urine.

FATS

Define fats and give the names and formulas of three fats.

Fats are compounds of the glyceryl radical and a fat acid radical; formed by glycerin and a fat acid.

Stearin (tristearin, glycerid of stearic acid), $C_3H_5(C_{18}H_{35}O_2)_3$.

Palmitin (tripalmitin, glycerid of palmitic acid), $C_3H_5(C_{16}H_{31}O_2)_3$.

Olein (triolein, glycerid of oleic acid), $C_3H_5(C_{18}H_{33}O_2)_3$.

What is a fatty acid? Give the names and formulas of three important members of the fatty acids.

A *fatty acid* is the oxidation product of an aldehyd and exists in nature in the form of a fat.

Stearic acid, $C_{18}H_{36}O_2$.

Palmitic acid, $C_{16}H_{32}O_2$.

Oleic acid, $C_{18}H_{34}O_2$.

Name the fat-splitting enzyme, and state where it is found in the human body.

Lipase (steapsin), found in the pancreatic juice and lately in small quantity in the stomach.

Give the action of the fat-splitting enzyme upon fats, and describe the various changes occurring during the process of digestion of fat in the intestines.

Lipase splits fat into *glycerin* and *fat acid*, the freed fat acid unites with the sodium carbonate in the intestinal juice, forming *soap*, which in turn, in conjunction with the bile, aided by the peristaltic action of the intestines, emulsifies the fat.

Define emulsion, saponification, and soap.

Emulsion is a liquid in which oil in minute subdivision is suspended by means of some mucilaginous substance.

Saponification is the process by which fats, when treated with an alkali, yield a salt of the fat acid and the metal called soap.

Soap is a fat acid salt of various metals, usually potassium or sodium.

How does the pancreatic ferment act on the fats?

It splits them into fat acid and glycerin.

Of what value are fats as foods?

They produce the greatest amount of heat or energy of all foods. One gram of fat yields 9.3 calories.

(a) To what class of chemical substances do the lecithins belong, and (b) what substances are formed by their decomposition in diseases involving nerve degeneration?

(a) Fats.

(b) Cholin, glycerin phosphoric acid, and fat acid. Cholin is a toxin.

PROTEINS (ALBUMINS)

What are proteins? Give examples.

Proteins (proteids) are very complex, unstable, mostly noncrystalline compounds comprising all albuminous substances, and are composed of C, H, O, N, and usually S. *Examples:* Egg albumin, fibrin, mucin, and gelatin. A few contain phosphorus and a few others iron. They are the nitrogenous food substances existing in animals and plants.

(a) What are proteids? (b) From what are they derived? (c) Name the chief proteids.

(a) Same as proteins (see preceding question).

(b) They are derived from plants and animals.

(c) Egg and serum albumin, proteoses (albumoses), peptones, and globulins.

Distinguish between a simple and a compound proteid. Give some decomposition products of proteids.

A *simple* proteid is an albumin containing C, H, O, N, and S, directly united to form an individual compound, as serum albumin.

A *compound* proteid is a complex body, composed of an albuminous radicle, combined with a non-albuminous group, as hemoglobin, which is composed of hematin and globin, the latter being the albuminous radicle.

Decomposition: When heated they char, giving off water, ammonia, inflammable gases, and emit an odor similar to that of burning hair or horn. By the action of bacteria they yield ptomains and leukomains, some of which are toxic. By the action of enzyms in the digestive processes they form *proteoses* (albumoses) and *peptones*, with other albuminous compounds.

Give some of the physical characteristics of proteids.

They are non-crystalline solids, except a few which have been obtained in the crystalline form; insoluble in water, but soluble in the presence of some mineral salt; non-diffusible, except peptones and albumoses.

What is albumin? Name a substance containing albumin, (a) as a liquid and (b) as a solid.

Albumin is a protein body composed of C, H, O, N, and S, having a very complex molecular structure, non-dialyzable, non-assimilable, but transformed into soluble, dialyzable, and assimilable compounds by the digestive processes. It is the principal part of protoplasm in plants and animal cells and the most important nitrogen-containing food.

(a) Milk.

(b) Meat.

How do globulins differ from ordinary albumins?

Globulins are insoluble in water, but soluble in a 1 per cent. solution of sodium chlorid, from which they may be precipitated by largely diluting with water; albumins are soluble in water without the sodium chlorid. Globulins contain less sulfur than albumin.

Define albumoses and give two tests for their detection?

Albumoses (proteoses) are protein compounds which result from the proteids through the action of the proteolytic enzymes or their hydrolytic decomposition, by means of weak acids or alkalies. They are somewhat diffusible, soluble in water, dilute saline solutions, and in dilute acids and alkalies.

Biuret Test: Add to the albumose solution sufficient potassium hydroxid or sodium hydroxid to render it distinctly alkaline, and then a 2 per cent. copper sulfate solution, drop by drop, and agitate; a *rose* color will be obtained.

Picric Acid Test: Picric acid added to the albumose solution yields a precipitate, soluble upon heating and reprecipitating on cooling.

Name some albumoses and give their origin.

Globulinoses, from globulins.
Vitelloses, from vitellins.
Caseoses, from caseins.
Gelatinoses (gelatoses), from gelatins.

What are peptones and how are they produced?

Peptones are end-products of the digestion of proteins (albumins) which are very soluble, diffusible, and assimilable. They are produced from albumoses by the action of proteolytic enzymes, as pepsin, trypsin, and erepsin.

How do the albumins differ from peptones? Give a test for peptone.

Albumins differ from peptones in being precipitated from their solutions by ammonium sulfate and other neutral salts, and by mineral acids, and in being coagulated when boiled. Albumins are non-diffusible and non-assimilable; peptones are.

Biuret Test: see page 100, fourth question; *rose* or *pink* color reaction.

Give the general definition and description of albuminoids.

Albuminoids are substances closely related to the albumins, containing less carbon and more oxygen than the albumins proper, and differing from them in many other particulars. They are not readily acted upon by the reagents, which easily react upon albumins. They are the horny, elastic, tough, gelatinous substances contained in bones, cartilage, connective tissue, nails, hair, and epidermis.

What are the chief substances known as albuminoid protein bodies?

Gelatin, collagen, elastin, and keratin.

What is mucin? Give its origin and a test by which its presence in solution may be detected.

Mucin is a compound proteid, either glycoproteid or nucleoproteid in character. It is collodial, insoluble in pure water, but soluble in weak alkalies, not coagulated by boiling, but gives many of the reactions of the albumins.

Mucin is secreted by the mucous glands, found in saliva, intestinal juice, connective tissue, and other parts of the animal body.

It is precipitated from its solutions by acetic acid, insoluble in excess of the acid.

Describe four tests for albumin.

Xanthoproteic Reaction: A few drops of concentrated nitric acid are added to the solid albumin or its solution and boiled; a *yellow* color results. On cooling and the addition of an excess of ammonium hydroxid a deep *orange yellow* color is produced.

Millon's Reaction: Solid albumin or its solution, when heated with Millon's reagent (solution of mercuric nitrate containing nitric acid), yields a *brick-red* solid.

Biuret Test: See page 100, fourth question.

Boiling (Coagulation) Test: When a solution of albumin is boiled, the albumin is coagulated, especially when one or two drops of nitric acid are added to the boiled solution.

Upon what property of albumin does its detection in any fluid depend?

Upon its ready coagulability or precipitation by heat or certain reagents, and upon the property of yielding color reactions, due to the contained aromatic groups.

Differentiate albumin and mucin and give tests for each.

Albumin is one of the simpler forms of the complex bodies called proteids, composed of C, H, N, O, and S. It is non-crystalline, unstable, soluble in water, from which it is readily precipitated by heat.

Tests: See page 101, last question.

Mucin: See page 101, fifth question.

In what part of the digestive tract are proteids (albumins) digested, and what are the active agents concerned?

In the stomach by *pepsin* (pepsase) in the presence of hydrochloric acid, and in the intestines by *trypsin* (trypase) in the presence of sodium carbonate.

Name the various substances produced from albumin by (a) gastric (peptic), and (b) by intestinal (tryptic, pancreatic) digestion.

(a) Albumin is changed into acid albumin, which changes into albumoses and peptones.

(b) Albumin
|
Alkali albumin
|
Albumoses (Proteoses)
|
(1) Primary { Protalbumose, Heteroalbumose }
|
(2) Secondary—Deutero-albumose
|
Amphopeptone

Antipeptone (true peptone) — Hemipeptone

Hemipeptone:

Hexon bases (diamino acids): Arginin, Histidin, Lysin

Mono-amino acids: Tyrosin, Leucin, Aspartic acid, Tryptophan

Mention the principal constituents of the several digestive secretions, and give the reaction of each secretion.

Saliva, Ptyalin, albumin, mucin, and inorganic salts, as the chlorids, carbonates, sulfates of sodium and other metals, and potassium sulfocyanid. *Reaction:* Slightly alkaline.

Gastric Juice: Pepsin, hydrochloric acid, rennin, lipase (a little), inorganic salts, as the chlorids and phosphates of sodium and other metals. *Reaction:* Acid.

Pancreatic Juice: Trypsin (trypase), amylopsin (amylase), steapsin (lipase), rennin (rennase), invertin (invertase), with inorganic salts. *Reaction:* alkaline.

Mention a secretion of the body that contains (a) cholesterin, (b) pepsin, and (c) trypsin.

(a) Bile; (b) gastric juice; and (c) pancreatic juice.

SALIVA

Give the composition of saliva.

Inorganic	Chlorids Carbonates Sulfates Nitrites	of	Sodium Potassium Calcium Magnesium
	Sulfocyanid of potassium		
Organic	Albumin Mucin Ptyalin (ptyalase) Epithelial cells		

How would you detect the presence of a sulfocyanid in the saliva?

By the addition of a few drops of ferric chlorid to the saliva a *red* color is produced.

How may mucin be detected in the saliva?

By the addition of acetic acid a *white* precipitate, or only a cloudiness is produced, insoluble in an excess of the acid.

How may mercury be detected in the saliva?

1. By boiling the saliva, slightly acidulated with hydrochloric acid, with a clean strip of metallic copper the mercury is deposited on the copper and when gently rubbed yields a mirror-like brilliancy; or, if the copper strip be dried and gently heated in a constricted glass tube, open at both ends, the mercury volatilizes and is deposited in the cooler part of the tube as black globules.
2. Potassium iodid added to the saliva would produce a *red* precipitate of mercuric iodid.

(a) What organs secrete ptyalin? (b) What action has it upon starches? (c) How is it influenced by acids?

(a) Parotid and submaxillary glands.
(b) It changes starches into sugar (maltose).
(c) Acids destroy its activity.

Describe ptyalin.

Ptyalin (salivary diastase) is the amylolytic enzyme of the saliva. It has never been isolated, and is therefore known only by its action upon starch.

Name the various products of salivary (ptyalytic) digestion of starches.

Starch
|
Soluble starch
|
Erythrodextrin + Isomaltose
|
Achroodextrin (alpha, beta, gamma) + Isomaltose
|
Maltodextrin + Isomaltose
| |
Maltose Maltose

In each of these stages beginning with erythrodextrin there is some isomaltose produced.

What is the normal reaction of saliva and to what is it due?

Slightly *alkaline*, due to sodium carbonate.

What salts form the tartar deposited on the teeth? What causes its formation?

Calcium phosphate and carbonate with mucus.

Cause: Alkaline reaction of the saliva derived from the ammonia in the breath and that produced by putrefaction of nitrogenous foods held between the teeth. The ammonia acts upon the soluble calcium phosphate in the saliva and precipitates it as basic calcium phosphate, $Ca_3(PO_4)_2$.

GASTRIC JUICE

Give the chemical composition of the gastric juice.

Water, 94.4 per cent.

Solids, 5.6 per cent.
- Inorganic
  - Chlorids, Phosphate of Sodium, Potassium, Calcium, Magnesium
  - Phosphate of iron
  - Hydrochloric acid
- Organic
  - Pepsin
  - Rennin
  - Lipase

What is the reaction of normal gastric juice, and to what is it due?

Acid, due to free hydrochloric acid, 0.2 per cent.

Describe the qualitative and quantitive determination of free hydrochloric acid in the gastric contents.

Before applying any test for hydrochloric acid the gastric material must be filtered.

Qualitative:

1. *Topfer's Test:* A small amount of filtered gastric contents, treated with 0.5 per cent. alcoholic solution of dimethlyamido-azobenzol, yields a *cherry-red* color in the presence of free hydrochloric acid.

2. *Gunzburg's Test:* A few drops of filtered gastric contents with an equal quantity of Gunzburg's reagent (2 gm. phloroglucin and 1 gm.

vanillin dissolved in 100 gm. of 80 per cent. alcohol) are carefully evaporated in a porcelain dish; when in the presence of free hydrochloric acid a *rose* color is obtained.

Quantitative:

Töpfer's Method: Titrate with decinormal sodium hydroxid solution 10 c.c. of filtered gastric contents, using 3 drops of a 0.5 per cent. alcoholic solution of dimethylamido-azobenzol as indicator, until the *red* color produced by the acid has changed to *yellow*. The number of cubic centimeters of decinormal solution required, multiplied by the value of 1 c.c. of decinormal solution in hydrochloric acid units (0.00365 gm.) gives the amount of free hydrochloric acid in 10 c.c. of the gastric contents, which result, multiplied by 10, gives the percentage of HCl.

Give the quantity of free hydrochloric acid contained in normal gastric juice, and the term employed to represent this condition.

0.15 to 0.3 per cent. Euchlorhydria.

Describe a test to determine an excess of hydrochloric acid (hyperchlorhydria) in the gastric contents.

See second question above, quantitative, Töpfer's method.

Write the chemical equation of the reaction occurring when sodium bicarbonate is administered for hyperacidity of the gastric juice.

$Na_2CO_3 + 2HCl = 2NaCl + H_2O + CO_2$.

Describe some chemical tests that would suggest the presence or absence of gastric carcinoma.

In cases of gastric carcinoma free hydrochloric acid is absent in the gastric juice, therefore determine its presence or absence by the tests for the free acid by Töpfer's and Günzburg's tests, given on pages 104 and 105.

Describe lactic acid, (a) give the cause of its presence in the stomach, and (b) a test for its detection.

Lactic acid is a colorless, syrupy, odorless liquid, having a strong acid taste. It is miscible with water, alcohol, and ether; insoluble in chloroform, carbon disulfid, and benzin.

(a) It is produced by the fermentation of carbohydrates by Bacterium lactis.

(b) *Uffelmann's Test* (*Carboloferric Test*): About 10 c.c. of the filtered gastric contents are extracted with 50 to 100 c.c. of ether by shaking in a separatory funnel for 20 to 30 minutes. The ethereal extract is evaporated to dryness on a water-bath containing boiling water, without the application of a flame, and the residue dissolved in a few cubic centimeters of distilled water. This solution is treated with Uffelmann's reagent (3 drops, each, of a saturated aqueous solution of ferric chlorid and a concentrated solution of pure carbolic acid, diluted with sufficient water to yield a *light amethyst* color), which produces a *canary* or *lemon-yellow* color in the presence of lactic acid.

Detail a method of detecting lactic acid in the presence of hydrochloric acid in the stomach, and state its significance.

Uffelmann's Test: See preceding question.

Its presence signifies fermentative changes occurring in the stomach by the action of Bacterium lactis upon the carbohydrates present.

When are acetic and butyric acids present in the stomach? Give a test for each.

They are present only when ingested with foods or as the result of fermentation of carbohydrates in the chyme.

Test for Acetic Acid: Ten c.c. of filtered gastric contents are extracted with ether. The ether is evaporated off, the residue dissolved in a few centimeters of water and accurately neutralized with sodium hydroxid, and 1 or 2 drops of ferric chlorid solution added. Acetic acid forms a ***dark red*** color of ferric acetate, which on being boiled precipitates as the ***reddish-brown*** basic salt.

Test for Butyric Acid: Ten c.c. of filtered gastric contents are extracted with ether. The ether evaporated off, the residue taken up in a few centimeters of water, and solid calcium chlorid added. The butyric acid will float as small oil globules on the surface of the solution, readily recognized by its pungent odor.

Describe pepsin and name the medium in which it is most active.

Pepsin appears as lustrous white, yellow, or yellowish transparent or translucent scales or a fine white or cream-colored amorphous powder, having a peculiar non-offensive odor and a slightly saline taste; soluble in water and glycerin, insoluble in alcohol, ether, and chloroform. It is the proteolytic enzyme of the stomach, changing proteins into peptones. It is most active in an acid medium.

BILE

Give the chemical composition of bile and the amount given off in twenty-four hours.

Water, 86.0 per cent.
Solids, 14.0 per cent.
- Mucin and pigments
- Salts of bile acids { Sodium taurocholate; Sodium glycocholate
- Soaps
- Fat
- Lecithin
- Cholesterin
- Inorganic salts { Sodium chlorid; Sodium carbonate; Calcium phosphate, etc.

The amount secreted in twenty-four hours varies from 500 to 1000 c.c., or 1 to 2 pints.

Where and how do the bile pigments originate?

They are secreted by the hepatic cells and are produced from the breaking down of the hemoglobin in the blood into globin and hematin, the latter passing into bilirubin, as shown by the equation:

$$\underset{\text{Hematin.}}{C_{32}H_{32}N_4O_4Fe} + 2H_2O - Fe = \underset{\text{Bilirubin.}}{C_{32}H_{36}N_4O_6}.$$

Name and describe the bile pigments.

Bilirubin, biliverdin, biliprasin, bilifuscin, and bilicyanin. They are the coloring matters of the bile, varying in color from golden-yellow, green, and bluish to brown. The bilirubin is the normal pigment of bile from which the others are produced by oxidation.

Define bilirubin, describe its properties, and give a test for its detection.

Bilirubin, as such, is a weak acid present in bile as sodium bilirubinate. It is only partly crystalline, of a golden-yellow or reddish-yellow color, insoluble in water, soluble in ether, choloroform, fatty oils, and alkalies. With nitric acid containing nitrous acid bilirubin yields a *play of color,* red, violet, blue, green, and yellow. It is the product of the breaking down of hemoglobin.

Describe a test for biliary acids.

Pettenkofer's Test: Biliary acids in aqueous solution, or bile treated with a few drops of 10 per cent. solution of cane-sugar and concentrated sulfuric acid, develop a *cherry-red* to *purple* color. The temperature must be kept below 70° C.; otherwise charring occurs.

Describe two tests for bile pigments in bile.

Gmelin's Test: Stratify bile with nitric acid containing nitrous acid; a *play of colors* of red, violet, blue, green, and yellow develops.

Smith's Test: Stratify bile with tincture of iodin diluted with alcohol in the proportion of 1 to 10; an *emerald-green* color is produced at the zone of contact.

Name the functions of the bile.

1. Aids in rendering alkaline the intestinal juice.
2. Emulsifies fats and forms soaps, and promotes their absorption.
3. Promotes the absorption of fats by stimulation of the intestinal villi.
4. Separates albumoses.
5. Stimulates the production of (activates) trypsin.
6. Produces intestinal peristalsis.
7. Holds soaps and cholesterin in solution.
8. The medium of excretion of pigments, cholesterin, and harmful compounds containing metals.

What are the chemical constituents of biliary calculi.

Bile acids, pigments, cholesterin, mucus, epithelium, fats, and calcium carbonate.

Give some of the physical characteristics of biliary calculi.

They are usually polyhedral in form, friable, and soapy or fatty to the touch, varying in color, either yellow, reddish, gray, brown, black, greenish, or white; white, when composed wholly or nearly wholly of cholesterin. A transverse section shows a nucleus of cholesterin, pigment, or other substance surrounded by concentric layers. They are insoluble in water, partially soluble in ether, chloroform, and alcohol.

BLOOD

Give the composition of blood.

- Water, about 91 per cent.
- Solids, about 9 per cent.
  - Red corpuscles (erythrocytes)
  - White corpuscles (leukocytes)
  - Blood plaques (platelets)
  - Inorganic salts — Carbonate, Phosphate, Chlorid — of Sodium
  - Proteins
    - Serum albumin
    - Serum globulin
    - Fibrinogen
  - Carbohydrates, fats, and waste organic material.

What is hemoglobin? Name some of its properties and its functions.

Hemoglobin is the red coloring matter of the blood and is a compound proteid composed of an albuminous radicle (globin) and an iron-containing pigment (hemochromogen), which very readily combines with oxygen to form hematin. Hemoglobin is a solid body of a red color, very soluble in water, especially when alkaline. Its function is to carry oxygen. It forms with oxygen a very unstable compound called *oxyhemoglobin*, which readily gives up its oxygen to the various tissues of the body.

What are the constituent elements of hemoglobin, and how does it differ from oxyhemoglobin?

C, H, N, O, S, Fe. Oxyhemoglobin contains two atoms of oxygen loosely combined with the molecule of hemoglobin.

What is the coloring matter of the blood, and what metallic element does it contain?

The coloring matter of blood is hemochromogen, present in the molecule of hemoglobin, and contains the metal iron.

Describe two chemical tests for blood.

1. *Guaiac or Hydrogen Peroxid Test:* To the blood is added freshly prepared tincture of guaiac and thoroughly mixed, then hydrogen dioxid or commercial turpentine, drop by drop, and shaken, when a blue color will be produced.

2. *Hemin Crystal Test* (*Teichmann's Crystals*): A drop of blood with a minute quantity of sodium chlorid placed on a glass slide and gently warmed, covered with a cover-glass, a few drops of glacial acetic acid

placed at the edge of the cover-glass, and again heated to boiling-point; then allowed to cool. Crystals of hemin separate. They are recognized by means of the microscope as dark-brown rhombic prisms or platelets, and are insoluble in water, alcohol, and ether, but soluble in alkaline solutions.

Describe a chemical test for the coloring matter contained in the erythrocytes of blood.

See preceding question, 1 and 2.

State how hemoglobin can be recognized.

By its red color, ready solubility in water, its avidity for oxygen and carbon monoxid, by its spectroscopic absorption band, and its chemical tests (see page 108, last question).

Describe a method by which human blood may be distinguished from the blood of other animals.

Bordet or Biologic Test: A small quantity of human blood is injected into the peritoneal cavity of a rabbit each day for several days, which forms a hemolysin and precipitin (*antibodies*) in the blood-serum of the rabbit. The blood is drawn from the rabbit and the serum, called the *specific serum*, collected under proper aseptic conditions and mixed with 0.9 per cent. sodium chlorid solution. This serum acts upon the albumin of human blood and causes a precipitate because precipitins react on closely related albumins, but are specific against those of unrelated species.

A. The suspected stain or clot is dissolved in, or the suspected fluid mixed with, 0.9 per cent. sodium chlorid solution and filtered.

B. Into each of four sterile test-tubes is placed the following: Tube No. 1: A definite volume of the filtered solution (A) to be examined with twice its volume of *specific serum*. Tube No. 2: A volume of the blood of an ox, or other animal unrelated to the human species, with 0.9 per cent. sodium chlorid, equal to the volume of the solution under examination in Tube No. 1, with twice its volume of *specific serum*. Tube No. 3: A volume of the suspected blood solution (A) equal to the amount employed in Tube No. 1. Tube No. 4: A volume of *specific serum* equal to the quantity employed in Tube No. 1. They are kept at 37° C. for one hour or for several hours at room temperature, when, if human blood was present in Tube No. 1, a cloudiness or precipitate should appear, but the others should remain clear.

Note: Tubes No. 2, 3, and 4 are control tests in which no change should occur.

What chemical change takes place in the blood and in the air breathed during respiration?

The hemoglobin in the blood becomes oxyhemoglobin by uniting with the oxygen of the air inspired, and the blood gives off carbon dioxid and other products of metabolism, which contaminates the expired air.

Give the chemical difference between the blood in the pulmonary artery and in the pulmonary vein.

The pulmonary artery carries venous blood and contains hemoglobin, carbon dioxid, and other products of the metabolic processes. The pulmonary vein carries arterial blood from the lungs and contains oxyhemoglobin, much less carbon dioxid than the blood in the pulmonary artery, and none of the other products of metabolism.

Describe in detail a chemicomicroscopic method for the identification of blood stains on cotton, wool, or other fabrics.

The stains are examined with a low power of the microscope with condensed reflected light. If blood is present the stain will have a bright, shining, and characteristic red color. Stains upon dark colored fabrics may be best detected by artificial light.

This method alone is not positive evidence of the presence of blood, therefore the stains are tested with tincture of guaiac and hydrogen dioxid, which yields a blue color when blood is present. The stains are dissolved by means of a weak solution of sodium hydroxid, or by means of glacial acetic acid and the hemin crystal test applied to a portion of the concentrated solution (see page 108, last question).

BONE AND MUSCLE

What are the chemical components of bone?

Organic matter, commonly called ossein, phosphates of calcium and magnesium, carbonate, chlorid and fluorid of calcium, and iron.

What inorganic salts enter into the formation of human bone? Which is most important?

Calcium phosphate	85.7 per cent.
Magnesium phosphate	1.5 per cent.
Calcium carbonate	11.0 per cent.
Calcium chlorid and fluorid	1.0 per cent.
Ferric oxid	0.8 per cent.

Calcium phosphate is the most important constituent.

Mention the principal constituents of muscle.

Water, 76 per cent.
Solid, 24 per cent., consisting of:

Proteins	17.6 per cent.
Collagen	3.0 per cent.
Fat	1.5 per cent.
Creatin	0.2 per cent.
Nitrogen-free extractives	0.4 per cent.
Salts $\left\{\begin{array}{l}\text{Chlorids}\\\text{Phosphates}\end{array}\right\}$ of $\left\{\begin{array}{l}\text{Na}\\\text{K}\\\text{Ca}\\\text{Mg}\\\text{Fe}\end{array}\right\}$	1.3 per cent.

What chemical changes take place as a result of muscular activity?

The tissues are oxidized into CO_2, urea, creatinin, uric acid, and the various purin compounds, and again rapidly repaired by formative material carried by the circulation.

MILK

Give the composition of human and cows' milk.

		Human.	Cow.
Water		87.41 per cent.	87.17 per cent.
Solids		12.59 per cent.	12.83 per cent.
Protein	Caseinogen	1.03 } 2.29 per cent.	3.02 } 3.55 per cent.
	Lactalbumin, Lactoglobulin	1.26	0.53
Fat (butter)		3.78 per cent.	3.69 per cent.
Sugar (lactose)		6.21 per cent.	4.88 per cent.
Ash		0.31 per cent.	0.71 per cent.

In what respect does human milk differ from cows' milk?

Human milk contains more sugar, fat, and water, and less proteid and ash than cows' milk.

What proteids (albumins) are found in milk?

Caseinogen, lactalbumin, and lactoglobulin.

Give the reaction, specific gravity, and percentage of cream of a specimen of normal cows' and human milk.

	Cows'.	Human.
Reaction	Alkaline or slightly acid.	Alkaline or amphoteric.
Specific gravity	1029 to 1034	1028 to 1034
Per cent. of cream	3.5 to 5	3.5 to 7

About what percentage of fats, proteids, and sugar should the following milk formula yield: Gravity cream, 5 oz.; skimmed milk, 5 oz.; sugar of milk, 1 oz.; water, a sufficient quantity to make 20 oz?

If the composition of cream was fat, 20 per cent.; protein, 3.55 per cent.; sugar, 3.52 per cent.; and of skimmed milk was fat, 0.74 per cent.; protein, 3.11 per cent.; sugar, 4.75 per cent.; then the mixture would contain: fat, 5+ per cent.; protein, 1.6+ per cent.; and sugar, 7+ per cent.; about, as shown by the following calculation:

$$\left.\begin{array}{l}100:5::\ \ 20:1.0\\100:5::0.74:0.037\end{array}\right\}1.037\text{ fat}$$

$$\left.\begin{array}{l}100:5::3.55:0.177\\100:5::3.11:0.156\end{array}\right\}0.333\text{ protein}$$

$$\left.\begin{array}{l}100:5::3.52:0.176\\100:5::4.75:0.237\end{array}\right\}\begin{array}{l}0.413\text{ sugar}\\\underline{1.000}\text{ sugar added}\\1.413\text{ Total.}\end{array}$$

in 11 oz. to be diluted with water to 20 oz.

Then, 20: 100:: 1.037: 5.185 per cent. fat.
20: 100:: 0.333: 1.665 per cent. protein.
20: 100:: 1.413: 7.065 per cent. sugar.

What is modified milk?

It is cows' milk altered by dilutions and additions to simulate, as nearly as possible, the composition of human milk.

Give a chemical explanation of the souring and curdling of milk.

The presence of Bacterium lactis in milk acts upon the lactose, forming lactic acid, which renders the milk sour and coagulates the caseinogen, which is the curds.

In what respect does sterilized milk differ from raw milk?

The process of sterilization destroys bacteria and enzymes present in the milk, coagulates the lactalbumin, the globulin, and modifies the caseinogen, thus altering the digestibility of the raw milk.

In the putrefaction of milk what toxin is produced?

Tyrotoxicon.

Name some substances used to prevent souring and to preserve milk, and describe a test for each.

Sodium carbonate, borax, boric acid, and formalin. Sodium carbonate: When 10 c.c. of milk are mixed with 10 c.c. of alcohol and a few drops of a 1 per cent. solution of rosolic acid added, a pink coloration would indicate the presence of sodium carbonate.

Borax and Boric Acid: To 10 c.c. of milk is added 5 drops of lime-water and evaporated to dryness over a low flame. The residue is completely charred, and the charred mass treated with a few centimeters of water slightly acidulated with hydrochloric acid and filtered. The filtrate, thoroughly mixed with alcohol and ignited, yields a green flame if borax or boric acid be present.

Formalin (Formaldehyd): (a) In some instances boiling the milk gives off the characteristic irritating odor of formaldehyd when it is present.

(b) An equal volume of milk and a mixture of sulfuric acid and a drop of ferric chlorid, stratified, produces a bluish-violet color at the junction of the two liquids if formaldehyd be present.

(c) A mixture of 10 c.c. of milk, 10 c.c. of hydrochloric acid, and one drop of ferric chlorid, heated to the boiling point with constant stirring, yields a violet-colored precipitate if formaldehyd be present.

Give the milk standard for the solids and fat content, as required by several states.

	Solids.	Fat.
Pennsylvania	12.5 per cent., not less.	3.0 per cent., not less.
New York	12.0 per cent., not less.	3.0 per cent., not less.
New Jersey	12.0 per cent., not less.	3.0 per cent., not less.

URINE

Give the average amount and the composition of normal urine voided by an adult in twenty-four hours.

Amount 1200 c.c. to 1500 c.c. or 40 to 50 ounces.

Average Composition.		Grams.	Percentage.
Water		1200	95
Solids		60	5
Organic	Urea	30.00	2.6
	Uric acid	0.65	0.05
	Hippuric acid	0.95	0.07
	Creatinin	0.95	0.07
	Pigments, mucus Xanthin and other extractives.	10.00	1.00
	Organic sulfates	0.15	0.015
Inorganic	Chlorids of Na and K	10.00	1.00
	Sulfates of K and Ca	2.60	0.11
	Phosphates of K and Na	2.90 as P_2O_5	0.2
	Phosphates of Mg and Ca	1.95 as P_2O_5	

Name bodily conditions affecting an increase in the elimination of urine and also those producing a decrease.

In health the quantity of urine is increased by the ingestion of much liquid or foods containing much water; when the perspiratory excretion or alvine discharges are lessened, as in a cold, humid atmosphere, after a cold bath, chilling of the surface of the body, etc.

In health urine is decreased by physical exercise, accompanied by free perspiration, and by conditions opposite to those mentioned above.

In disease urine is increased in diabetes mellitus, in cirrhosis of the kidneys, certain nervous disorders, etc., and decreased in diseases accompanied by high fever, as typhoid and other infectious fevers; in acute inflammation of the kidneys, etc.

How much of each of the following ingredients will be found in the urine of an adult who passes 50 oz. (1500 cc.) of normal urine daily: (a) urea, (b) chlorids, (c) phosphates, and (d) sulfates?

(a) 620 gr. or 40 gm.
(b) 132.5 gr. or 15 gm.
(c) 93 gr. or 6 gm.
(d) 54 gr. or 3.5 gm.

(a) State the reaction of normal urine. (b) How is the reaction noted? (c) To what is the reaction due?

(a) *Acid.* (b) By means of litmus paper (blue), which is burned red when dipped into the urine. (c) Acidity is due to acid phosphate of sodium.

(a) What reaction of the urine favors the deposition of gravel, uric acid or uric acid calculi, and (b) what is the reaction of the urine during the formation of a phosphatic calculus ?

(a) Acid. (b) Alkaline.

Urine on standing undergoes what change in reaction and why? What effect does this change have upon the constituents of the urine?

The urine becomes alkaline, due to the production of ammonium carbonate, by the action of Micrococcus ureæ upon the urea. The alkalinity thus produced precipitates the urates and phosphates of the alkaline earth metals (Ca and Mg).

State (a) the specific gravity of normal urine, and (b) the causes of deviations in the specific gravity of urine.

(a) From 1015 to 1025.

(b) It is increased in diabetes mellitus, in the early stages of acute parenchymatous nephritis, etc., and diminished in diabetes insipidus, chronic parenchymatous nephritis, and by the free use of beverages containing little solid matter.

In febrile affections and certain digestive disorders it may be increased or decreased.

Give the uses of the urinometer. State its importance as an aid in diagnosis.

It is used to determine the specific gravity of the urine.

It aids in determining whether the amount of solids eliminated is normal or abnormal, thereby indicating the character of diet to be prescribed and the regimen in cases of disease.

The quantity of urine being insufficient for the urinometer, how would you proceed to determine the specific gravity?

1. By diluting the urine with one, two, or three volumes of water, determining the specific gravity by means of the urinometer, and multiplying the number of the division mark by the total number of volumes used in the process of dilution. *Example:* Suppose three volumes of water have been added to one volume of urine, thus making four volumes, and the urinometer stood at 1006, then the urine would have a specific gravity of $1000+(4\times6)=1024$.

2. With the *pyknometer* (specific gravity bottle).

The flask being equipoised, it is weighed when filled with urine and when filled with water. The weight of the urine is divided by the weight of the water. *Example:* Weight of urine, 20.5 gm.; weight of water, 20 gm. $20.5 \div 20 = 1025$, or 20:20.5::1:1025.

What are the principal pigments in normal urine? (a) What is their origin? (b) Give tests for their detection.

Urochrome, urobilin, and uroerythrin (purpurin, rosacic acid).

(a) They are derivatives of the coloring matter of blood and bile.

(b) *Urochrome:* A large volume of urine (1 liter) acidulated with 1 or 2 drops of dilute sulfuric acid and saturated with ammonium sulfate, precipitates the urochrome. The precipitate is dried and decomposed with an acid, yielding an amorphous reddish-brown substance.

Urobilin: Ten cubic centimeters of urine with a few drops of hydrochloric acid and half its volume of amyl alcohol thoroughly shaken, and a few drops of a 1 per cent. alcoholic solution of zinc chlorid, rendered strongly alkaline with ammonium hydroxid, yield a beautiful green fluorescence.

Uroerythrin: The salmon-red color of urates and uric acid sediments in the urine is due to this pigment. When the urine is freed from urates and uric acid by strongly acidulating with hydrochloric acid, and treated with neutral acetate of lead, uroerythrin is thrown down with the precipitate and colors it salmon-red. The pigment extracted from the precipitate by boiling alcohol and rendered alkaline with caustic soda produces a dark green color. The solutions of all three pigments show bands of absorption in the spectrum.

UREA

How may urea be detected in the urine? Give the amount of urea excreted normally by an adult in twenty-four hours.

1. Evaporate a few drops of urine and a drop of nitric acid on a glass slide and examine under the microscope; colorless rhombic plates or hexagonal scales of urea nitrate will be observed.

2. By extracting urea from the urine after having been treated with baryta mixture. The urea crystals are heated until biuret is formed, which is dissolved in water, and the biuret reaction applied. (After the solution has been rendered alkaline with caustic soda the addition of a few drops of a 2 per cent. solution of copper sulfate added yields a violet color).

3. By adding sodium hypobromite to the urine, producing nitrogen gas by the decomposition of the urea present.

Amount excreted is from 30 to 35 gm.

How would you prepare a chemical reagent to test for the quantity of urea in urine?

Dissolve 100 gm. of sodium hydroxid in water, dilute with water to 250 cc. and when cool add 75 gm. (25 cc.) of bromin. This forms the *sodium hypobromite solution.*

Describe a method for the quantitative estimation of the urea eliminated in the urine in twenty-four hours.

Fill a *Hinds-Doremus ureometer* with freshly prepared sodium hypobromite solution and carefully introduce 1 cc. of urine. The urea is decomposed into water, carbon dioxid (absorbed by the alkali in the sodium hypobromite solution), and nitrogen gas, which collects at the top of the graduated tube. The tube is graduated into 0.001 gm. of urea. When decomposition is complete (about fifteen minutes), the amount of urea in 1 cc. of the urine is read off and multiplied by 100 to obtain the percentage and the percentage is multiplied by the number of 100 cc. of urine voided in twenty-four hours.

Note: Any other of the various forms of ureometers may be employed in a similar manner, the quantity of urea being calculated from the number of centimeters of nitrogen evolved, remembering that 0.002688 gm. of urea yields 1 cc. of nitrogen.

Name some pathologic conditions which (a) increase and (b) decrease the amount of urea eliminated in the urine.

(a) Acute febrile diseases, diabetes, pneumonia, and phosphorus poisoning.

(b) Hepatic diseases, as acute yellow atrophy, carcinoma, Weil's disease, and cirrhosis; renal disease in which the uriniferous tubules are affected, and chronic affections impairing the vitality of the patient.

What quantity of the nitrogen eliminated in the urine is in the form of urea?

Eighty-five per cent.

Uric Acid

What is the normal amount of uric acid excreted in the urine by an adult in twenty-four hours, and what effect has diet on the quantity so excreted?

From 0.5 gm. (7.7 gr.) to 1.0 gm. (15.5 gr.).

Uric acid is increased by the ingestion of albumins, especially those containing nucleoproteids, as sweetbreads, liver, young flesh; also by alcoholic beverages. It is diminished by a diet consisting of vegetables containing little albumin.

What is the appearance, macroscopically and microscopically, of urine containing an excess of uric acid?

Such urine has a somewhat darker color than normal urine and a sediment of a reddish color resembling brick-dust.

Microscopic examination reveals crystals of a yellowish-brown or reddish-brown color, having a great variety of shapes and sizes, as rhombic lozenges with round, pointed, or obtuse ends, double wedges with serrated edges, crosses, rosettes, etc.; also urates as amorphous granules, forming moss-like groups, pinkish in color. They form the "brick-dust" sediment.

What are the distinguishing characteristics of urates and of uric acid as deposited in the urine.

Urates are amorphous granules in moss-like groups of a pinkish color, or crystalline needle-like clusters, or arranged like sheaves of wheat or fans, and are converted by acids, as HCl, into uric acid; whereas uric acid is crystalline, having the various forms described in previous answer. They form the "brick-dust" sediment.

What is the composition of the ordinary brick-dust deposit in urine?

Uric acid and urates colored by uroerythrin.

How could you determine chemically whether a urinary deposit was composed of urates or phosphates?

By flowing a drop of sodium hydroxid under the cover-glass while the specimen is being examined under the microscope the urates will dissolve, leaving the phosphates unaltered. If now a few drops of acetic acid be added, the phosphates dissolve and small crystals of uric acid soon appear.

In what form is uric acid normally eliminated in the urine? Give the solubility of uric acid.

In the form of urates, especially of sodium and potassium, which are either neutral or acid in character. It is soluble in 16,000 parts of cold and 2,000 parts of hot water. Soluble in alkaline solutions and in sulfuric acid, insoluble in hydrochloric acid, alcohol, and ether.

How may uric acid be obtained from the urine?

By rendering the urine strongly acid with hydrochloric acid, crystals of uric acid separate out on standing twelve to twenty-four hours.

How may the presence of uric acid in the urine be determined?

By evaporating some urine in a porcelain dish to dryness on a water-bath, treating the residue with a few drops of nitric acid, again evaporating to dryness, cooling, and adding a drop of ammonium hydroxid. A beautiful red color of murexid ("murexid test") is produced, or a purple color with potassium or sodium hydroxid.

How is an excess of uric acid or urates in a sample of urine determined?

1. *Heintz Method:* Add to 200 cc. of filtered albumin-free urine 10 cc. of hydrochloric acid and allow to stand twenty-four hours. Collect the

uric acid crystals on equipoised filters, wash with 30 cc. of water, dry, and weigh. Divide the weight obtained by 2 to obtain the percentage and compare it with the normal percentage.

2. *Ruhemann's Uricometer:* Place carbon disulfid in the glass tube to the mark S, and a solution consisting of 1.5 gr. iodin, 1.5 gr. potassium iodid, 15 gr. absolute alcohol and 185 gr. distilled water to the mark J. Then add urine to the mark 2.45 (2.6 cc.). Close the tube with the glass stopper and shake. The carbon disulfid assumes a dark, *copper-brown* color. More urine is slowly added and shaken after each addition until the carbon disulfid turns *porcelain-white* and the urine looks like cloudy whey. (No more urine is added when the carbon disulfid shows only a slight reddish tint, as this color will disappear after repeated shakings.) Any foam remaining is removed by moving the tube slowly to a horizontal position a few times and bringing it back to the upright position, removing the stopper a little to allow all the carbon disulfid to settle at the bottom of the tube. The proportion of uric acid is then read off where the surface of the liquid cuts the graduation on the tube as parts in a thousand.

3. There may be a brick-dust deposit in the urine when uric acid or urates are in excess and the urine is distinctly acid.

What do (a) uric acid and (b) oxalate of lime (calcium oxalate) crystals in the urine signify?

(a) Uric acid crystals signify vigorous physical exercise; ingestion of a rich nitrogenous diet, as meat; free indulgence in alcoholic liquors; or waste of nitrogenous tissues of the body, as occurs in acute febrile diseases, in paroxysms of the gouty or rheumatic diathesis (lithemia), pneumonia, and during the recovery from acute exanthems or acute nephritis, etc.

(b) They signify either the ingestion of certain acid fruits and vegetables, such as apples, oranges, bananas, certain berries and grapes, tomatoes, *rhubarb*, asparagus, spinach, and turnips; impaired digestion or retarded metabolism; inflammation of the pelvis of the kidney, and sometimes also of the kidney proper.

Give in order of frequency the possible chemical composition of urinary calculi.

1. *Uric Acid:* 70 to 80 per cent. of all concretions are formed of either uric acid alone or combined with urates of sodium, potassium, and ammonium.

2. *Calcium Oxalate:* Either small, round, and smooth, called "hemp-seed calculi," or large, rough masses called "mulberry calculi."

3. *Phosphates:* (a) Calcium phosphate.

1. $CaH_4(PO_4)_2$, acid.
2. $CaHPO_4$, neutral.
3. $Ca_3(PO_4)_2$, basic.

(b) Magnesium ammonium phosphate (triple phosphate), $MgNH_4PO_4$.

(c) Fusible phosphates composed of (a) and (b) varieties, with more or less organic matter.

Rarer forms are:

1. Cystin with calcium carbonate.
2. Indigo and xanthin.

Give a chemical test by which each of the commoner forms of urinary calculi may be recognized.

Heat a portion of the powdered concretion on platinum foil.

1. *The powder burns without a flame,* yields no odor of ammonia on heating with sodium hydroxid, and gives the murexid test (see page 94, fourth question, Uric Acid).

Ammonium urate yields NH_3 odor on heating with NaOH, as well as the other tests for uric acid.

2. *The powder does not burn.* Treated with hydrochloric acid:

(a) Effervesces = calcium carbonate.

(b) *Does not effervesce.*

1. Effervesces only on heating gently with HCl and the original powder insoluble in acetic acid = calcium oxalate.

2. Soluble in HCl, reprecipitated when neutralized with NaOH as crystalline triple phosphate; heating with NaOH yields odor of NH_3 = magnesium ammonium phosphate.

3. Soluble in HNO_3, reprecipitated upon being neutralized with NH_4OH; no odor of NH_3 when heated with NaOH = one or more of the varieties of calcium phosphate.

Explain the formation of a vesical calculus having a uric acid nucleus.

Crystals of uric acid separate from the urine and cause irritation of the vesical mucous membrane with the secretion of a large amount of mucus, which forms a layer around the crystals. The inflammation produced by the irritation may cause alkaline decomposition of the urine, with the formation of alkaline urates and various forms of phosphates, which deposit around the mass, thus forming a mixed calculus. More or less epithelium may be deposited with each concentric layer.

Organic Sulfates

What is (a) the origin of organic (ethereal, aromatic, conjugate) sulfates in the urine, (b) the form in which they are excreted, and (c) in what diseases are they increased in the urine?

(a) The putrefaction of albumins in the intestinal tract from whatever cause, and putrefactive processes in the body proper, with active resorption from the diseased area.

(b) As indol, skatol, phenol, and paracresol; in combination with sulfuric acid as sodium or potassium salts.

(c) In constipation, enlargement, catarrh, and cancer of intestine or stomach, malignant tumors of any part of the body, and lead colic.

What is the normal amount of organic sulfates eliminated in the urine in twenty-four hours?

From 0.094 to 0.62 gm.

Describe a test for organic sulfates in the urine.

From 100 cc. to 200 cc. of urine, slightly acidulated with hydrochloric acid, an excess of barium chlorid is added and allowed to stand several

hours. The precipitate of barium sulfate produced by the inorganic sulfates is filtered off and the filtrate boiled with more hydrochloric acid and barium chlorid, when more white precipitate of barium sulfate produced would indicate the presence of organic sulfates.

Describe two tests for the detection of potassium indoxyl sulfate (indican, uroxanthin).

Jaffe's Test: Mix equal volumes of urine and strong hydrochloric acid (about 10 cc.), in a test-tube, add a few cc. of chloroform, and drop by drop of some oxidizing agent, as bromin or chlorin water, sodium hypochlorite, peroxid of hydrogen, and shake after each addition. The chloroform dissolves the indigo produced, which, after settling to the bottom of the tube, presents a blue color.

Obermayer's Test: About 10 cc. of urine is treated with an equal volume of concentrated hydrochloric acid containing 0.3 per cent of ferric chlorid, and the indigo-blue is extracted as in Jaffe's test by shaking with a few cc. of chloroform.

(a) What is the normal quantity of indican voided daily in the urine? (b) In what pathologic conditions is indican increased in the urine?

(a) It is represented by about 0.066 per cent. of indigo.

(b) See page 118, third question, (c).

In what pathologic conditions is indol found in the urine, and how may its presence be detected?

In rectovesical fistula, pyelonephritis, and cystitis. It may be detected by Jaffe's or Obermayer's test (see first question on this page).

Chlorids and Phosphates

(a) Name the chlorids found in the urine, (b) state their clinical significance, and (c) give a test for their detection.

(a) Sodium chlorid, chiefly, with some potassium and ammonium chlorid.

(b) A diminution signifies decreased ingestion of sodium chlorid; acute stages of febrile diseases, as pneumonia, typhoid, puerperal fever, and acute articular rheumatism; diseases associated with exudation or transudation (dropsy), vomiting, or diarrhea.

Increased quantity is due to an abundance of sodium chlorid in the food ingested. A marked increase occurs in diabetes insipidus. Increased during absorption of exudates and transudates with increased diuresis; also by certains drugs, as diuretics, chloroform, and salicylates.

(c) To about 10 cc. of urine, rendered acid with nitric acid, silver nitrate is added, when a white, curdy precipitate of silver chlorid is produced.

What is the quantity of chlorids voided in normal urine daily?

Ten to 15 gm., calculated as sodium chlorid.

How are chlorids chemically recognized in urinalysis?

See second question above, (c).

Describe a method for the determination of the quantity of (a) the chlorids, and (b) the phosphates in the urine.

(a) *Mohr's Volumetric Method:* Take 10 cc. of urine, add 50 cc. of water and 8 to 10 drops of neutral potassium chromate solution, then titrate with standard silver nitrate solution (1 cc. = 0.010 gm. NaCl or 0.006065 gm. Cl.) until a permanent orange-red color is produced. Subtract 1 cc. of silver nitrate solution (to allow for the amount of silver consumed by organic matter) from the number of centimeters required and multiply by 0.010 gm. or 0.006065 gm., and then by 10 to obtain the percentage of NaCl or Cl.

(b) *Uranium Method:* Take 50 cc. of urine, add 5 cc. of sodium acetate solution, of which 1 liter contains 100 gm. sodium acetate, 100 cc. of 30 per cent. acetic acid, and a few drops of tincture cochineal. Heat to boiling, and then from a buret run in the standard uranium acetate solution (1 cc. = 0.005 gm. P_2O_5), until a faint, permanent green color is produced. Multiply the number of centimeters of uranium acetate required, and then by 2 to obtain the percentage of P_2O_5.

Give a test for the detection of phosphates in the urine.

Render some urine distinctly acid by means of nitric acid, add some ammonium molybdate solution, and boil. A yellow precipitate of ammonium phosphomolybdate indicates the presence of phosphates.

In what pathologic conditions are the phosphates (a) decreased, and (b) increased in the urine?

(a) In most acute febrile diseases; in chronic diseases accompanied by decreased metabolism, as nephritis, amyloid kidney, and anemias; in hysteria, Addison's disease, and acute yellow atrophy.

(b) In diabetes mellitus, phosphaturia, and sometimes in typhoid fever during the fastigium.

In what form is ammonia found in the urine?

As the chlorid and phosphate. In decomposed urine as ammonium carbonate and as crystals of magnesium ammonium phosphate (triple phosphate).

Abnormal Constituents of Urine

Name some of the abnormal chemical constituents of urine.

Glucose albumin, blood, bile, acetone, diacetic acid, albumoses, peptone, leucin, tyrosin, lecithin, and cholesterin.

Describe a mode of procedure in making a chemical examination of urine suspected of containing abnormal substances.

Determine the reaction with litmus paper, the specific gravity with the urinometer. Note the color, transparency, and the character of sediment. Test separate portions of the urine for glucose, albumin, bile, blood, acetone, diacetic acid, etc.

Give the characteristics of (a) diabetic urine, (b) nephritic urine, and (c) cystitic urine.

(a) *Diabetes.*—A large quantity of clear, light-colored urine having

a high specific gravity, 1030 to 1060, sweet odor and taste, readily undergoing fermentation, due to the presence of glucose.

(b) *Nephritis.*—In the *acute* stage there is a diminished quantity, of a smoke-hue color, due to the presence of blood, and at first a high specific gravity, 1025 to 1030, which diminishes as it advances into the chronic stage.

In the *chronic* stage the specific gravity may be normal or low, usually 1010 or 1008; the color light. In both stages albumin and casts are present and all the normal constituents diminished. On standing it readily undergoes putrefaction.

(c) *Cystitis.*—*Acute* form: Usually diminished in quantity, of a bloody or smoky color, and strongly acid reaction; specific gravity early in the disease is usually high, 1025 to 1030; later it is normal or slightly diminished, 1022 to 1015. It contains albumin relative to the amount of blood and pus present. Sediment is abundant, consisting of blood-corpuscles, pus, and various forms of epithelium.

Chronic form: Moderately diminished quantity, generally pale, but may be normal in color or very slighty tinged with blood. The freshly-passed urine is generally turbid, due to the presence of pus, epithelium, and bacteria. The reaction is frequently alkaline, but may be acid; specific gravity varies between 1012 and 1020. The sediment is abundant, consisting chiefly of pus, small round cells, epithelium, and usually a small (sometimes considerable) amount of blood. If the urine be alkaline (ammoniacal), the sediment contains also amorphous phosphates, triple phosphate crystals, and often crystals of ammonium urate.

GLUCOSE

Describe the tests you would employ in testing urine for glycosuria.

(a) *Fehling's Test:* Mix 1 cc. of Fehling's solution with about 4 cc. of water and boil, then slowly add urine and boil after each addition; a yellow precipitate of cuprous hydroxid or a red precipitate of cuprous oxid is produced if glucose be present.

(b) *Nylander's Test:* To about 10 cc. of urine add 1 cc. Nylander's reagent (see page 97, second question) and boil; when in the presence of sugar a reduction of the bismuth subnitrate to bismuthous oxid or metallic bismuth occurs. The mixture assumes a grayish, dark-brown, or black color, and on standing, the precipitate together with the earthy phosphates settles to the bottom of the tube.

(c) *Phenylhydrazin, Fischer's, or Williamson's Test:* In an ordinary test-tube place ¼ inch of powdered phenylhydrazin hydrochlorid and twice its volume of sodium acetate. Half fill the tube with urine and boil in a water-bath for twenty minutes. Set aside to cool. In the presence of glucose sulfur-yellow, needle-shaped crystals of phenylglucosazon separate out, which are examined microscopically, and a melting-point determination made. They melt at 204° to 205° C.; or a mixture of 5 drops of pure phenylhydrazin, 10 drops of glacial acetic acid, 1 cc. of a saturated solution of common salt, and 3 cc. of urine are boiled for two minutes and then set aside to cool. The crystals are examined as above.

Describe the fermentation test and Trommer's test for glucose in the urine.

Fermentation Test: Compressed yeast is mixed with some urine and placed in a saccharometer tube, such as Einhorn's, and then allowed to stand until the glucose present ferments, yielding carbon dioxid, which collects at the top of the tube.

Two control tests should be made, one with yeast and water, and another with yeast and normal urine. The volume of gas (if any) produced is compared with that obtained with the urine under examination.

Trommer's Test: To about 10 cc. of the urine in a test-tube about one-fourth its volume of sodium or potassium hydroxid is added, and then copper sulfate solution, drop by drop, shaking after each addition, until the precipitate of cupric hydroxid produced is no longer dissolved. The upper part of the tube is then heated, when a yellow precipitate of cuprous hydroxid or a red precipitate of cuprous oxid will be produced if glucose be present. The unheated portion remains unchanged.

Give (a) the appearance, specific gravity, and odor usual to diabetic urine, and (b) describe Fehling's test for sugar in the urine.

(a) See page 120, last question, (a). (b) See page 121, Glucose, (a).

If the copper reaction is doubtful in a test for glycosuria, give a positive test.

The phenylhydrazin test, see page 121, last question, (c).

What substances in the urine, other than glucose, may produce the reaction of Fehling's test?

Phosphates, uric acid, glycuronic acid, lactose, and homogentisic acid.

How would you differentiate between the phosphatic reaction and the glucose reaction in Fehling's test, when applied to urine?

Phosphates.	*Glucose.*
Reddish, flocculent precipitate (earthy phosphates + coloring matter).	Red or yellow, granular precipitate (cuprous oxid, Cu_2O, or cuprous hydroxid, $CuOH$).
Solution remains transparent.	Solution becomes opaque.
The precipitate is unevenly distributed throughout the liquid.	The precipitate is evenly distributed throughout the liquid.
The precipitate settles slowly, does not form a compact layer at the bottom of the tube, and is easily disturbed.	The precipitate settles rapidly, forming a compact layer at the bottom of the tube, and is not readily disturbed.

Write the equation representing the reaction occurring when Fehling's test is applied to urine containing glucose.

$$\underset{\text{Glucose.}}{2C_6H_{12}O_6} + \underbrace{10CuSO_4 + 20NaOH + KNaC_4H_4O_6 + H_2O}_{\text{Fehling's Solution.}} = 5Cu_2O.$$

$+ 10Na_2SO_4 + (H_2O)_x + (KNaC_4H_4O_6)_x +$ tartronic ($C_3H_4O_4$), gluconic ($C_3H_{12}O_7$), and melassic acids + unknown substances.

How would you make Fehling's solution? How is it best kept?

Dissolve 34.652 gm. of non-effloresced, crystallized copper sulfate in water and dilute to 500 cc. Solution A.

Dissolve 173 gm. of Rochelle salt in 480 cc. sodium hydroxid solution of a density of 1.14, or 173 gm. Rochelle salt and 212 gm. sodium hydroxid are dissolved in water and diluted to 500 cc. Solution B.

Equal volumes of A and B solutions mixed = Fehling's solution, 1 cc. of which = 0.005 gm. of glucose. It is best kept in separate solutions, as given above, protected from sunlight.

Describe a rapid method for determining the approximate amount of sugar in diabetic urine.

One centimeter of Fehling's solution is placed in a test-tube, diluted with 4 cc. of water, and boiled. Then urine is added, drop by drop, boiling after each addition until the blue color is discharged and the number of drops noted. The number of drops is divided by 2 to obtain the number of tenths of a cubic centimeter, and then the figure 5 divided by the number of 0.1 cc. converted into whole numbers to obtain the percentage of sugar.

Example: Suppose 16 drops were required to discharge the blue color of 1 cc. of Fehling's solution, and 2 drops represent a tenth of a cubic centimeter; then $16 \div 2 = 0.8$ cc. = 8 whole numbers. One cubic centimeter of Fehling's solution = 0.005 gm. of glucose, therefore 0.8 cc. of urine contained 0.005 gm. of glucose; so, $0.8 : 100 :: 0.005 : x = 0.625$ per cent. glucose; or $5 \div 8 = 0.625$ per cent. glucose.

Give a reliable quantitative method for sugar in the urine.

Fehling's Method: Place 10 cc. (0.050 gm. glucose) of Fehling's solution into a beaker with 40 cc. of water and boil. Run into it from a buret the urine previously diluted with water, in the proportion of one part urine with nine parts water, constantly boiling, until the blue color is discharged (complete reduction of the copper to cuprous oxid). Read off the number of centimeters of diluted urine required and calculate the percentage of glucose, as follows:

Suppose 20.5 cc. diluted urine required. One-tenth of $20.5 = 2.05$ cc. undiluted urine required = 0.050 gm. glucose. Then, $2.05 : 100 :: 0.050 : x = 2.43+$ per cent. glucose.

ALBUMIN

Describe the characteristics of the urine in a case of Bright's disease.

See page 121, (b).

(a) What is the nature of the albumin in the urine in morbus Brightii? (b) What properties render it readily detectable?

(a) Serum albumin.

(b) Its ready coagulability by heat, acids, or certain reagents.

What conditions of the urine would lead to the suspicion of the presence of albumin?

A light color, low specific gravity, the production of a well-formed white foam on shaking, the presence of tube casts, and its rapid putrefactive change.

Describe three tests for albumin in the urine, and explain fully the necessary precautions in making these tests.

Heller's Test: Stratify 1 inch of urine on an equal volume of nitric acid in a test-tube; in the presence of albumin a white zone of precipitated albumin occurs at the point of contact of the liquids.

Precaution: Various colored zones produced by other substances, as bile, blood, etc., must not be mistaken for albumin. A white zone is produced by the presence of abietic acid occurring in the urine after the ingestion of balsams, as copaiba. It is soluble in alcohol; albumin is not.

Boiling or Heat Test: Boil some urine in a test-tube. A flocculent precipitate indicates either earthy phosphates or coagulated albumin. One or two drops of nitric acid are added to the hot liquid. If the precipitate be dissolved, it is composed of phosphates; if undissolved, it is albumin. If no precipitate appear on boiling, the nitric acid is to be added, and if albumin be present it will be precipitated.

Precaution: Distinguish between phosphates and albumin. If the urine be cloudy it must be filtered before applying the test.

Note: The test may be applied by filling a test-tube three-quarters full and boiling the upper portion, then adding the acid and comparing the boiled with the unboiled portion.

Potassium Ferrocyanid Test: A few centimeters of urine are strongly acidified with acetic acid (one volume of urine to one-fourth volume of acetic acid) and 10 per cent. solution of potassium ferrocyanid added, drop by drop; in the presence of albumin a precipitate occurs, varying in amount with the quantity present.

Precaution: Albumoses and urates precipitate, but redissolve on warming; the albumoses reprecipitate on cooling. Mucin responds to the test, but may be removed by precipitating with plumbic acetate, filtering, removing the lead from the filtrate by hydrogen sulfid, and applying the test.

(a) In testing urine by heat in a case of suspected albuminuria, what substance might be precipitated and so make the test deceptive. (b) How may these substances be differentiated from the precipitate of albumin, and (c) how may they be separated from the urine before applying the test for albumin?

(a) Earthy phosphates (calcium and magnesium phosphate).

(b) By their solubility in nitric acid; albumin being insoluble.

(c) By rendering the urine alkaline with sodium or ammonium hydroxid, allowing to stand a few minutes, then filtering off the precipitated earthy phosphates and applying the test for albumin to the filtrate.

A urine contains pus and gives an albuminous reaction. How would you determine whether the albumin be due to the pus alone or to nephritis as well?

Filter off the pus and to the filtrate apply the boiling and Heller tests (see preceding question), for albumin. A positive reaction indicates nephritis.

Give a clinical method for the quantitative determination of albumin in urine.

Esbach's Albuminometer: Fill the tube with urine to the mark U and with reagent (1 per cent. picric acid, 2 per cent. citric acid in water) to the mark T. Close the tube with a stopper, gently mix by inverting the tube several times, and stand aside for twenty-four hours. Read off the column of precipitate where the top of the precipitate comes in contact with a line on the scale. The figures on the scale represent the number of grams of albumin in 1000 cc. of urine.

Give a reliable method for the quantitative determination of albumin in a nephritic urine.

Gravimetric Method: Place 100 cc. of urine in a beaker, bring to the boiling-point in a water-bath, and slightly acidulate with acetic acid, continuing the boiling several minutes. Collect the precipitate on equipoised filter papers, wash with boiling water containing a few drops of acetic acid, then with ether and alcohol; dry until constant in weight. The result represents the number of grams of albumin in 100 cc. of urine.

What form of albumin is present in normal urine and how is its presence detected?

Mucin (nucleoalbumin).

Test: Dilute some urine with water and add acetic acid, drop by drop, until distinctly acid in reaction. A white cloud or precipitate insoluble in excess of the acid indicates the presence of mucin.

Give a test for albumosuria and peptonuria.

Saturate a large volume of urine with ammonium sulfate and heat to the boiling-point. Filter while hot.

The precipitate: Wash the precipitate while on the filter with alcohol. Then extract the precipitate with boiling water, which dissolves the albumoses, and apply the biuret reaction (see page 100, last question).

The filtrate: Concentrate the filtrate by heat, and cool. Filter off the excess of ammonium sulfate and apply the biuret test (see page 100, last question) to the filtrate.

Blood and Bile

By what chemical tests may the presence of blood in the urine be detected.

See page 108, last question, 1 and 2.

Give the characteristics of an icteric urine.

It is of a golden-yellow, greenish, or reddish-brown color, due to the amount and character of biliary coloring matter present, producing, when fresh, a yellow foam when shaken.

What pathologic changes produce bile in the urine?

Acute yellow atrophy, hepatic cirrhosis, inflammation of gall-bladder, breaking down of red corpuscles, and extravasations in other parts of the body.

How would you detect the presence of bile in the urine?

See page 107, Gmelin's, Smith's, and Pettenkofer's tests (see page 107).

How may the presence of biliary acids in the urine be detected?

See page 107, Pettenkofer's test.

Acetone and Diacetic Acid

Describe tests for determining acetonuria.

From 250 to 500 cc. urine with 1 cc. phosphoric acid are distilled and the first 15 to 30 cc. of distillate tested by:

Legal's Test: A few centimeters of the distillate, rendered alkaline with sodium hydroxid, are treated with a few drops of freshly prepared solution of sodium nitroprussid. In the presence of acetone a red color develops, rapidly fading away, but replaced by a carmine or purple-red color when treated with an excess of acetic acid. On standing the color changes to a bluish-violet.

Lieben's Test: A few centimeters of the distillate, rendered alkaline with sodium hydroxid, are treated with a few drops of iodopotassic iodid solution, which in the presence of acetone yields a yellowish precipitate of iodoform, recognized by its odor.

In what pathologic conditions is acetone present in the urine, and it is often accompanied by what substances?

In diabetes mellitus, tuberculosis (advanced stages), infectious fevers, and carcinoma.

It is accompanied by diacetic acid and sometimes by beta-oxybutyric acid.

When is diacetic (aceto-acetic) acid found in the urine? Give a test for its presence in the urine.

In diabetes mellitus, infectious fevers, pneumonia, pleurisy, pericarditis, and appendicitis.

Test: A few centimeters of urine are treated with a few drops of ferric chlorid solution, when a reddish phosphatic precipitate forms, which is removed by filtration. The filtrate is treated with a few more drops of ferric chlorid, and in the presence of diacetic acid a red color develops, which fades on standing, or is rapidly discharged by boiling the solution.

What substances ingested are eliminated in the urine, which, with ferric chlorid, yield a similar reaction as diacetic acid? How may they be distinguished from diacetic acid?

Salicylic acid, antipyrin, kairin, and other phenol products.

Differentiation: The red color produced by ferric chlorid with diacetic acid is discharged, but is not discharged when produced by the other compounds mentioned, upon the application of heat.

If the urine be boiled before treatment with ferric chlorid, diacetic acid fails to produce a color, the other compounds yield the red color.

To what is the term alkaptonuria applied, and what is the origin of the substance which produces it?

To a urine containing homogentisic acid, which readily oxidizes on exposure to the air and sunlight, changing the color of the urine to a dark-brown to black. It has the property of reducing Fehling's solution, yielding a black precipitate.

Homogentisic acid is formed from tyrosin, which is a cleavage product of the proteid molecule in the intestinal digestion.

Give a test for alkaptonuria.

Urine rendered distinctly alkaline with sodium hydroxid and shaken becomes dark-brown to black if homogentisic acid be present.

PHYSIOLOGY

THE BLOOD

Describe the physical appearance and characteristics of the blood. Compare arterial with venous blood.

The color varies from bright red in the arteries to dark blue in the veins. It is an alkaline liquid with a salty taste, a characteristic odor, and a specific gravity of about 1055. When exposed to the air or brought in contact with a foreign body, blood coagulates. Arterial blood is a brighter red, contains more oxygen and less carbon dioxid, and coagulates more readily than venous blood.

Name some of the bodily states which lessen the alkalinity of the blood.

(a) Exercise, which is attended by the development of acid in the muscles; (b) digestion, when the diet contains an excess of proteids or is deficient in alkaline mineral salts; (c) lactation; (d) rheumatism, gout, and the acid intoxication of diabetes.

Why does blood remain fluid in the body in life, and coagulate when shed?

Because blood does not undergo coagulation while it is in immediate contact with the living and unaltered vessel wall. In shed blood the disintegration of the white corpuscles liberates the fibrin ferment, or *thrombin*, and clotting takes place.

How can fresh blood-stains be distinguished from older blood-stains?

Fresh stains are brighter in color and the clot is more flexible; an old blood-stain is darker and more friable.

What is the normal proportion of blood in the human body, and how is it renewed after hemorrhage?

In the adult the blood is equal to one-thirteenth of the body-weight; in the newborn about one-nineteenth. The liquid portions of the blood are renewed from the ingested food and liquids; the corpuscles from the bone marrow, spleen, and lymphatic tissues.

Give the amount of blood, in pounds, in the body of a person weighing one hundred and forty-three pounds.

Eleven pounds.

Describe the process of coagulation of the blood.

Coagulation is a fermentative process that consists in the transformation of the soluble albumin of the plasma or *fibrinogen* into the solid substances of the fibrin, through the action of an enzyme which is called *fibrin ferment* or *thrombin*. Both fibrinogen and fibrin ferment are formed by the disintegration of white blood-cells. The fibrin forms a meshwork of threads in which the blood-corpuscles become entangled, thus forming the clot or *coagulum*, which at once begins to contract.

What conditions retard, suspend, or prevent the coagulation of blood?

Contact with a living vessel wall; cold (0° C.); the addition of alkalies, ammonia, concentrated solutions of neutral salts of alkalies and earths, peptone; the addition of oxalic acid (by precipitating the calcium); the addition of egg albumin, sugar solution, glycerin, and soaps; contact with a foreign substance to which the blood cannot adhere, as, for instance, oily objects; the disease known as hemophilia.

Give the composition, reaction, and uses of blood.

Composition: Blood is composed of serum, or plasma, and corpuscles in the proportion of 60 to 40. The solid matter consists of proteids, serum albumin, serum globulin, fibrinogen, and various salts: compounds of sodium, calcium, potassium, and magnesium in combination with chlorin, phosphorus, and carbon dioxid. Other substances contained in the blood are fats, urea, uric acid, dextrose, and cholesterin.

The blood is *alkaline* in reaction from the presence of disodium phosphate.

The *function* of the blood is to carry oxygen and nutriment to the tissues and to convey waste material to the excretory organs. It also assists in maintaining a uniform body temperature.

(a) State the average specific gravity of the blood; (b) state some causes of variation in specific gravity.

(a) About 1055. (b) The specific gravity is *increased* after hemorrhage; in diabetes, owing to the quantity of glucose in solution in the blood; in congestive states; during digestion; in diarrhea (cholera morbus, Asiatic cholera); and during profuse sweating. The specific gravity is *diminished* in the anemias; temporarily after the copious ingestion of food; in dropsy and general anasarca; and after ligation of the ureters.

What changes take place in the composition of the blood as it passes through the kidneys?

It gives up urea, uric acid, sodium chlorid, alkaline and earthy phosphates, sodium and potassium sulfates, indican, extractives, and water. The blood loses oxygen and takes up carbon dioxid, so that it becomes venous as it leaves the kidneys.

Describe the red blood-corpuscles as to (a) origin and fate, (b) form, (c) size, (d) number, and (e) function.

(a) The red blood-cells are derived from *erythroblasts* which are formed in the bone-marrow; they are destroyed in the liver and, to some extent, in the spleen and bone-marrow. (b) The red blood-cell is coin- or biscuit-

shaped; (c) from 6 to 7.5 mmm. in diameter; (d) the number in adult males is over five millions; in females about four millions in a cubic millimeter of blood (Landois). (e) The function of the red blood-cells is to convey oxygen to the tissues.

Describe the red blood=corpuscles. Give the best known and most important function of the red blood=corpuscles.

Red corpuscles are non-nucleated, biconcave disks 7.5 mmm. ($\frac{1}{3200}$ in.) in diameter; singly, as seen under the microscope, they are green; in large masses they appear red. The chief function of red blood-cells is to carry oxygen to the tissues. In the capillaries of the lungs the hemoglobin contained in the red blood-corpuscles combines with the absorbed oxygen to form *oxyhemoglobin*. The latter is carried to the heart by the pulmonary veins and propelled by the heart into the general circulation until it finally reaches the capillaries, where the oxygen is readily taken up by the tissues from the oxyhemoglobin, the oxygen being very loosely combined. The blood is then collected from the tissues by the veins and carried back to the lungs, where the hemoglobin of the red blood-cells again becomes oxygenated. The red cells also carry small amounts of carbon dioxid from the tissues to the lungs.

What is the usual difference in shape between the red blood=corpuscles of the mammalia and those of the ovipara?

Mammals, with the exception of the camel, llama, alpaca, and similar animals, all have circular, coin-shaped, biconcave, non-nucleated red blood-cells; in the ovipara the cells are oval, biconvex, and nucleated.

Describe hemoglobin and mention its derivatives.

Hemoglobin is a colloidal, proteid-like substance which, however, is readily crystallizable and contains iron and sulphur. It has a strong affinity for oxygen and other gases and gives a peculiar spectrum. The derivatives are: *hematin*, *hematöidin*, *hemin*, *hematoporphyrin*, and *methemoglobin*.

Describe the white blood=corpuscles, giving source, composition, and properties.

The leukocytes are larger than the red cells, being $\frac{1}{2500}$ in. in diameter, nucleated, and capable of ameboid movement and phagocytic action. They contain nuclein, globulin, fat, glycogen, and a nucleoproteid. There are several varieties: small and large lymphocytes; polymorphonuclear, transitional, and eosinophile leukocytes, the last containing large granules that stain readily with eosin. The leukocytes are derived from the lymphatic tissues, the spleen, and the bone-marrow.

Give the number of leukocytes in shed blood under normal conditions.

From 5000 to 10,000 in a cubic millimeter of blood.

What is the ratio of leukocytes to red blood=cells in shed blood under normal conditions?

About 1:500 to 800 (Jaksch).

Define leukocytosis.

An increase of the number of leukocytes above 10,000 in a cubic millimeter of blood.

What explanation may be given for enlargement of the spleen in leukocythemia?

The spleen is one of the organs in which white corpuscles are formed.

What is the chemical reaction of (a) blood, (b) urine, (c) sweat, (d) uterine secretion, and (e) vaginal secretion?

(a) Alkaline; (b) acid; (c) acid during rest, neutral or alkaline after exercise; (d) alkaline; and (e) acid.

What is the function of the suprarenal glands? What is the effect of their removal?

The function is practically unknown; they are believed to inhibit excessive pigment formation and to destroy certain poisonous substances in the body. In Addison's disease, tuberculous degeneration of the suprarenal glands, the skin is bronzed.

The injection of suprarenal extract causes contraction of the arteries and an increase in the blood-pressure, with slowing of the pulse by central stimulation of the vagus. The heart muscle is also stimulated.

Extirpation of both glands is followed by death with symptoms of poisoning and paralysis.

(a) Give function of thyroid gland. (b) What effect does its removal have?

(a) Function unknown. *Theories:* (1) The thyroid produces an internal secretion rich in iodin. This reaches the circulation and constitutes an important regulatory mechanism. (2) According to another theory the thyroids neutralize or destroy toxic substances. (3) Lyon believes that they serve through their large vascular supply as a protection to the circulation of the brain. The first theory has the best foundation of observed facts.

(b) Removal of the thyroids and parathyroids in dogs leads to muscular tremors, convulsions, emaciation, apathy, and death. It is now generally believed that the acute symptoms arise from the ablation of the parathyroids. Removal of the thyroids proper leads usually to malnutrition and a condition resembling myxedema in man.

THE CIRCULATORY SYSTEM

State what are, under normal conditions, (a) the adult pulse-rate; (b) adult number of respirations per minute; (c) body temperature; and (d) average respiratory capacity.

(a) Seventy-two per minute; (b) 18 per minute; (c) 98.4° F.; and (d) 230 cu. in.

Give the extremes of slowness and rapidity of the heart's action consistent with physical vigor and with ability to perform manual labor.

It is not possible to define the extreme limits, say from 50 to 100 beats per minute.

What causes (a) circulation of the blood, and (b) the beating of the pulse?

(a) The circulation of the blood is caused by the contraction of the cardiac muscle, reinforced by the tonicity of the arteries and vasomotor system (*vis a tergo*) and the negative pressure in the venous system.

(b) The pulse-beat represents the cardiac contractions transmitted to one of the peripheral arteries, usually the radial.

State the manner in which the blood circulates through the heart and the lungs, beginning at the right auricle.

From the right auricle through the tricuspid valve to the right ventricle; from the right ventricle through the pulmonary valve into the pulmonary artery, which carries the blood to the air-cells in the lungs. From the capillaries surrounding the pulmonary vesicles the blood is collected by the pulmonary veins and emptied into the left auricle; thence it passes through the mitral valve into the left ventricle and from there is propelled through the aortic valve into the aorta and general arterial system.

Give the physiology of (a) blushing, (b) pallor, and (c) tear-shedding.

(a) Blushing is due to reflex dilatation of the blood-vessels in the skin brought on by stimulation of the vasodilator center in the medulla. This stimulation may be brought about by any emotional disturbance.

(b) Pallor is a reflex constriction of the blood-vessels of the skin and is due to reflex excitation of the vasoconstrictor center in the medulla.

(c) Under the influence of certain emotions, particularly grief and vexation, the lacrimal glands are reflexly stimulated through the central nervous system to secrete more fluid than can be carried off through the nasal duct, and this excess runs over the cheeks in the form of tears.

Describe a complete physiologic revolution of the heart.

During diastole the ventricular muscles relax and the blood passes from the auricles into the ventricles; the auricles contract as diastole comes to an end and force the remaining blood into the respective ventricles. With the beginning of systole the ventricles contract, the auriculoventricular valves are closed, and the blood is forced into the pulmonary artery and aorta, respectively, through the open semilunar valves. As diastole begins and the ventricles relax, the semilunar valves close with a snap, the auriculoventricular valves being opened by the pressure within the auricles and the negative pressure in the ventricles.

Describe the mechanism of the opening and closing of the aortic valve.

During systole the pressure of the ventricles opens the leaflets of the aortic valve, which are placed with their convexity toward the ventricle.

At the end of systole, as the aorta closes down on the column of blood, the blood-pressure is raised and the blood is forced against the concave surface of the aortic cusps and fills up the pockets with which they are provided. This forces the free edges of the leaflets together and closes the orifice.

Describe the normal heart-sounds.

The first sound is somewhat duller, longer, and lower in pitch than the second sound, which is clearer, shorter, snapping in quality, and higher pitched. The first sound is separated from the second by a short interval, and the second from the succeeding first sound by a longer interval. The heart-sounds are sometimes imitated by the syllables "*lub-dup*" or "*bu-tup.*" The first sound is heard best at the apex and is systolic in time; the second sound is heard at the base and is diastolic in time.

Describe the factors which cause the heart-sounds.

The *first* sound is caused by (1) the impact of the heart against the chest wall; (2) the contraction of the ventricular muscle; and (3) the tension and vibration of the auriculoventricular valves and their tendinous bands. The first two factors are the most important.

The *second* sound is due to the closure of the semilunar valves.

What is the office of the columnæ carneæ?

They brace the ventricular wall and prevent the auriculoventricular valves from being forced into the auricles.

What are the causes of the apex-beat of the heart?

(a) Impact of the apex against the chest wall; (b) change in the shape of the cardiac cone; and (c) change of position: the ventricles rotate slightly around their long axes.

Explain the diastolic filling of the heart, and describe how each involved factor performs its function.

The auricles contract in a wave-like manner, from above downward, forcing the blood into the relaxed ventricles. Backward flow is prevented by the pressure in the superior vena cava and in the pulmonary veins and by the presence of valves in the superior and inferior cavæ. Aspiration of the blood with negative pressure by virtue of the inherent elasticity of the ventricular walls is possibly also a minor factor. The auriculoventricular valves close.

Do variations in the rate and force of respiration affect the heart, and if so, in what manner?

There is a direct proportion between the rate and force of respiration and the rate and force of the heart-beats. A deep inspiration held for some time will reduce the frequency of the heart.

What nerves control the action of the heart?

(a) Intrinsic mechanism, consisting of ganglia in the heart wall; (b) extrinsic mechanism, consisting of cardio-inhibitory and cardio-accelerator fibers.

The cardio-inhibitory center is situated in the nucleus of the spinal accessory nerve and the impulses are conveyed through fibers of that nerve to the *pneumogastric*, which is the great cardio-inhibitory nerve. The cardio-accelerator center is hypothetic and is probably situated in the medulla. The fibers pass out through the first five dorsal nerves (particularly the second and third) to the sympathetic ganglia, from which fibers pass to the heart as the cardiac sympathetic nerves. The pneumogastric nerve also contains some accelerator fibers.

What effect is produced on the heart's action by stimulation of the cardio-inhibitory center?

Inhibition going on to complete cessation of the heart in proportion to the force of the stimulation.

In what manner is the heart-beat influenced by the pneumogastric nerve?

Stimulation of the pneumogastric nerve causes slowing of the heart. If the stimulation is continued, the heart-beat is accelerated, because the accelerator fibers in the pneumogastric are stimulated after the inhibitory fibers have ceased to react.

What is understood by endocardiac pressure?

The pressure of the blood within the auricles and ventricles of the heart during systole, which is as follows:

Left auricle, 50 mm. of mercury; right auricle, 20 mm. of mercury; left ventricle, 150 mm. of mercury; and right ventricle, 150 mm. of mercury.

The pressure gradually diminishes and becomes negative during diastole.

State the causes of the pressure in the (a) arteries, (b) capillaries, and (c) veins.

(a) The propelling force of the left ventricle and the resistance of the elastic arterial wall under the influence of the vasoconstrictor center.

(b) The *vis a tergo*, derived from the arteries.

(c) In the upper veins near the heart the negative pressure of the heart during diastole, which diminishes in proportion to the distance from the heart. The contraction of the muscles surrounding the veins and the valves found in some portions of the body also assist in keeping up the venous pressure.

What do you understand by blood-pressure?

The tension or pressure of the blood in the circulatory system. In the larger arteries (radial) it is equal in the adult to from 140 to 160 mm. of mercury.

Describe the conditions within normal physiologic limits which increase arterial blood-pressure.

Whatever directly or indirectly increases the force of the heart-beat or stimulates the vasomotor center, as digestion, exercise, emotions, respiration (inspiration), and posture (the pressure is less in the standing posture, increased in the sitting posture, and greatest in the recumbent posture).

Describe the pulse mechanism, state the factors active in its maintenance, and give the average rate during infancy, youth, and adult age.

The pulse-wave is due to the projection of a certain quantity of blood into the arterial system, causing an additional distention of the already filled vessels. The factors active in its maintenance are the force of the heart, the controlling influence of the cardiac mechanism, and the elasticity of the arteries. The normal pulse should be full, of moderate tension, regular, and of the normal frequency, which is 130 to 140 during infancy, 80 to 90 during youth, and 70 to 80 during adult life; *normal*, 72.

Describe the sphygmograph and state its use.

An instrument for graphically recording the pulse-wave. It consists of a spring fastened at one end and provided at the other with a round pad which presses on the radial artery. By means of a system of levers the movements of the arterial wall are transmitted to a writing lever provided with a delicate point, which records the movements of the pulse on a smoked surface. The latter is made to pass in front of the point at a uniform rate by means of clockwork.

Give in language or by drawing the sphygmographic tracing in aortic insufficiency.

The ascending limb is high and abrupt and is followed by an equally abrupt down-stroke, which is interrupted by a small dicrotic or recoil wave. The apex of the curve is pointed. This is the so-called Corrigan or water-hammer pulse.

Mention some of the exercises that injuriously affect the heart. State the reasons for your conclusions.

Any exercise which throws a sudden strain on the heart has a tendency to cause *dilatation* and eventually *hypertrophy*. Among these may be mentioned wrestling, bicycle riding, long-distance running, and rowing, especially in a race.

What are the functions of the blood-vessels?

They convey the blood to and from the various parts of the body, distributing the nutritive substances to the tissues and removing the waste materials, which they carry to the organs through which they are excreted. They also regulate the amount of blood going to various portions of the body, control the amount of work that is thrown on the heart, and assist in maintaining the normal body heat.

Describe the structure of the arteries. How do arteries exercise their function?

Arteries are provided with three coats, the *tunica intima*, *media*, and *adventitia*. The intima consists of an inner layer of endothelial cells and a layer of yellow elastic tissue. The media is principally made up of circular fibers of involuntary muscle containing a number of elastic fibers. The media contains ganglionic masses which represent the endings of the vasomotor nerves. The adventitia, or outer coat, contains yellow elastic fibers and strands of fibrillated connective tissue.

The arteries exercise their function of conveying the blood to the tissues by virtue of their inherent elasticity, due to the elastic tissue contained in their coats and the influence of the vasomotor center on the muscular fibers.

How do veins, arteries, and capillaries differ as to (a) structure and (b) function?

The arterial walls contain more muscular and elastic tissue than that of the veins. Veins are larger in caliber than their corresponding arteries; their walls are thicker and many of them are provided with valves, which are not found in arteries. The walls of the capillaries consist of a single layer of nucleated, spindle-shaped, and polygonal endothelial cells.

The arteries convey the blood from the heart to the capillaries, and the veins carry it back to the heart. The capillaries effect the interchange of nutritive substances from the blood to the tissues by means of osmosis and diapedesis, and carry away waste material in the opposite direction.

Compare arteries, veins, and capillaries in respect to rapidity of the blood-stream.

The rate in the arteries is from 260 to 360 mm. (12 in.) a second; in the small veins 25 mm. (1 in.); venæ cavæ, 200 mm. ($7\frac{3}{4}$ in.); and capillaries, 5 mm. (2 in.).

How is the venous blood-current maintained? What arteries carry venous blood?

By the *vis a tergo*, or force of the heart, transmitted through the arteries and capillaries; the contraction of the surrounding muscles; the action of the valves in some of the veins; and (in the large veins near the heart) the negative pressure in the right side of the heart during diastole.

What is the relation of the capillaries to the circulation?

They form the intermediate link between the small arterioles and the smallest veins.

Describe the process of osmosis, and give examples in the human economy.

Osmosis is the diffusion of liquids through a porous membrane. The current is in the direction from the liquid of lower specific gravity to the liquid of higher specific gravity or concentration. The liquids must be miscible, of different specific gravity, and capable of wetting the membrane without acting on it mechanically. The solid constituents must be crystalloid in order to pass through the membrane.

Examples in the human economy are the passage of plasma through the capillary wall into the tissues in both directions, and the passage of glucose from the intestine into the portal circulation.

Describe the movements of the blood-corpuscles in the capillaries, and explain the phenomena of diapedesis.

The *red* corpuscles occupy the central or axial portion of the stream and travel more rapidly than the white blood-cells, which have a tendency

to adhere to the vessel wall. The capillaries are just large enough to allow the red blood-corpuscles to pass through in single file, and at the junction of two capillaries they take alternate turns in passing into one or the other.

The *white* blood-cells, by virtue of their ameboid movement, are able to pass through the capillary wall. One of the pseudopods is thrust through the cement substance between the cells of the capillary wall and then pulls the rest of the cell body through after it. This process is called diapedesis.

RESPIRATION

Define the process of respiration.

External respiration consists in the interchange between gases of the outer air and those of the blood contained in the lungs and skin; *internal* or tissue respiration is the exchange of gases between the capillary blood and the body tissues.

What is the purpose of respiration?

To supply the body with the necessary oxygen for its oxidation processes and to remove the carbon dioxid resulting from combustion.

Give the mechanism of respiration.

This consists in alternating dilatation and contraction of the thoracic cage; the dilatation is termed *inspiration* and the contraction, *expiration*. The lungs lie wholly passive within the thoracic cavity, and by virtue of their complete elasticity follow every change in the capacity and shape of the thorax. Enlargement of the thorax is effected by certain muscles known as the muscles of inspiration; the diaphragm descends and at the same time is withdrawn from the chest walls; the ribs are elevated and rotated outward. At the end of inspiration the muscles relax and the thorax collapses, expiration being usually a passive process due to the elasticity of the lungs, the weight of the chest, the tension of the abdominal muscles, and the torsion of the costal cartilages. It is also assisted to some extent by the action of the muscles of expiration. The respiratory movements are controlled by a center in the medulla.

State the changes in the diameter of the chest in inspiration and expiration.

During inspiration the vertical diameter is increased by the descent of the diaphragm; the posterior and transverse diameters by elevation, eversion, and anterior and lateral rotation of the ribs. During expiration the original conditions are restored. The circumference of the chest, measured at the level of the nipples, is increased by from one-twelfth to one-seventh of the circumference in the expiratory position.

How is the diaphragm affected in expiration?

The central tendon of the diaphragm is drawn up into the thorax during expiration by the negative intrathoracic pressure, which results from the collapse of the lungs and in part from the contraction of the abdominal muscles.

Give the mechanism of the diaphragm in hiccough.

The muscle is thrown into sudden spasmodic contraction, causing a jerky inspiration, which is arrested by sudden closure of the glottis.

What is the normal ratio of respirations to heart pulsation?

In adults one to four; in infants one to two.

What is meant by the term vesicular murmur?

The sound heard over the lungs during normal respiration.

Define and describe (a) respiratory rhythm, and (b) respiratory sounds.

(a) The time relation between the two respiratory phases; inspiration is to expiration as five to six, expiration being followed by a short pause.

(b) There are two varieties of respiratory sounds: *Vesicular* breathing and *bronchial* breathing. Vesicular breathing is low-pitched and soft, and is described as *breezy*, sipping, rustling, or hissing; expiration is somewhat lower in pitch, less loud, and shorter than inspiration, the relation being as one to three or four. It is heard over pulmonary tissue. Bronchial breathing, heard over the trachea and large bronchi, is blowing or tubular in quality, and expiration is louder, longer, and higher pitched than inspiration.

Describe the function of the mucous membrane of the respiratory tract.

1. The mucus secreted by the glands arrests dust particles and other foreign bodies in the inspired air, and the ciliated epithelial cells keep the lungs clear of accumulations of mucus and the suspended dirt particles.

2. The squamous cells lining the air vesicles, by virtue of their vital activity, play a part in the exchange of respiratory gases.

What changes are produced in the air and in the blood by respiration?

Expired air is warmer, contains less oxygen, and more carbon dioxid, nitrogen, and water than inspired air. It also contains volatile organic substances. The blood coming from the lungs contains more oxygen, and less carbon dioxid and nitrogen, than that entering the lungs.

How is asphyxia produced? What are the causes of death from asphyxia?

1. By the failure of air to enter the lungs, as in obstruction of the air-passages by false membrane or foreign body, or by external constriction, as in strangulation.

2. The absence of oxygen in the inspired air.

3. Anything that interferes with the supply of oxygen to the tissues, as edema of the lungs or other diminution of the respiratory surface, or cardiac insufficiency. Death from asphyxia is caused by deficiency of oxygen and the accumulation of carbon dioxid in the blood.

Define and give the physiologic significance of (a) dyspnea, (b) dysphagia, and (c) apnea.

(a) Difficult and rapid breathing due either to a lack of oxygen or to an excess of carbon dioxid in the blood. In oxygen dyspnea the inspirations are frequent and vigorous; carbon dioxid dyspnea is characterized by slow, deep, and vigorous expirations. Dyspnea in disease of the heart and lungs is chiefly due to a lack of oxygen; dyspnea following exertion is due to the action on the respiratory center of accumulated carbon dioxid.

(b) Difficult or painful deglutition from obstruction or spasm of the esophagus, or painful affections of the thorax.

(c) Cessation of breathing due to mechanical excitation of the pulmonary plexus of the pneumogastric nerve, which inhibits the respiratory center, and the storage of sufficient oxygen in the lungs to last through one circuit of the blood through the body.

What is the composition of atmospheric air? State the permissible limit of CO_2 in air.

Air is a mechanical mixture containing oxygen, 20.92 per cent. (by volume); nitrogen, 79.02 per cent.; CO_2 0.029 to 0.034. It also contains 1 per cent. of argon; helion, crypton, and certain other gases. Air contains a variable quantity of aqueous vapor.

The permissible limit of CO_2 in air is 0.07 per cent.

Define (a) tidal air, (b) complemental air, (c) reserve air, (d) residual air, and (e) respiratory capacity.

(a) The normal flow of air in the lungs, amounting to 30 cu. in. or 500 cc.; (b) the amount of air which may be inspired after an ordinary inspiration; it is equal to 100 cu. in. or 1500 cc.; (c) the amount of air which may be expired after an ordinary expiration; it is equal to 90 to 120 cu. in. or 1250 to 1800 cc.; (d) the air which remains in the lungs after a forced expiration and which cannot be forced out; it amounts to 90 to 100 cu. in., or 1200 to 1500 cc. (e) By respiratory or *vital capacity* is meant the volume of air which can be expired after forced inspiration; it therefore includes the reserve, tidal, and complemental air. In man it amounts to about 3400 cc.; in woman 2500 cc.

What is the volume of air taken into the body during an ordinary inspiration? How much of this is oxygen and how much of the oxygen is absorbed?

This is equal to the tidal air and amounts to 30 cu. in. or 500 cc.; of this 20.92 per cent. or 6.27 cu. in. or 104 cc. is oxygen. About 5 per cent. or 5.2 cc. of oxygen is absorbed.

Locate the respiratory center.

The respiratory center is situated in the medulla oblongata behind the point of exit of the vagi at the posterior extremity of the floor of the fourth ventricle. It is bilateral, each half governing its own side of the body particularly, but not exclusively.

What post-mortem tests should be applied to prove that air has entered the lung of a supposedly stillborn child?

The trachea should be tied and the lungs removed from the body and placed in water. If they float, it is a sign that air has entered the lungs.

If respiration has begun during life, the thorax is less flat and the diaphragm displaced further downward; the lungs are brighter in color and crepitant if air has entered.

State the effect on respiration of dividing (a) one phrenic nerve, and (b) both phrenic nerves.

(a) Unilateral paralysis of the diaphragm and cessation of diaphragmatic breathing on the side of the lesion; and (b) complete cessation of diaphragmatic breathing and death.

DIGESTION

What is meant by digestion?

The process by which the food ingested is prepared for absorption within the body.

Name the secretions of the alimentary canal, their reactions, and functions.

SALIVA: *Alkaline;* assists in forming the bolus and lubricating it for deglutition, and converts starch into maltose.

GASTRIC JUICE: *Acid;* inhibits fermentation, converts proteids into peptones, and coagulates the casein of milk.

PANCREATIC JUICE: *Alkaline;* continues the process of changing proteids into peptones and starch into maltose; converts caseinogen into casein, and splits up, saponifies, and emulsifies fats.

BILE: *Alkaline;* contains no ferments, assists in neutralizing the acid chyme, aids in the emulsification and in the absorption of fats, stimulates peristalsis, counteracts putrefaction, and acts as a lubricant to the intestinal wall.

SUCCUS ENTERICUS: *Alkaline;* is secreted by the crypts of Lieberkuhn; changes maltose into glucose and saccharose into sugar. Its digestive action is very feeble.

Name the active principles of the digestive secretions and state how each affects the food.

SALIVA: *Ptyalin* in saliva changes starch into maltose.

GASTRIC JUICE: *Pepsin* in the presence of *hydrochloric acid* converts proteids into albuminoses and peptones. *Rennin,* the milk-curdling ferment, converts caseinogen into casein. Lactic-acid ferment converts sugar of milk into lactic acid.

PANCREATIC JUICE: *Trypsin* changes proteids into peptones; *amylopsin* changes starch into maltose; *steapsin* splits up fat into fatty acids and glycerin; *rennin* coagulates milk; *invertin* changes maltose into dextrose; and saccharose into equal parts of dextrose and levulose.

SUCCUS ENTERICUS contains an amylolytic ferment of feeble activity, and *invertin.*

BILE contains no ferment, but assists in the digestion of fat.

Give the physical properties of saliva.

It is an opalescent, tasteless, and odorless, somewhat ropy fluid, with a specific gravity of 1002 to 1006, and an alkaline reaction due to alkaline phosphates.

State the composition and mechanical functions of the saliva. What relation does the saliva bear to the sense of taste?

Organic constituents: an albuminous substance, mucin, and ptyalin. *Inorganic constituents:* sodium chlorid, potassium chlorid, potassium sulfate, alkaline and earthy phosphates, and ferric phosphate.

The saliva dissolves articles of food soluble in water; moistens such as are ingested in the dry state, assists in the formation of the bolus, and facilitates deglutition by lubricating it with mucus.

In order that a substance may make a gustatory impression, it must be soluble in the saliva; insoluble substances have no taste.

What influences has the saliva on digestion?

The secretion is *amylolytic* or diastatic, that is, it converts starch into maltose and dextrose. The action is due to *ptyalin.*

What are the uses of (a) saliva, (b) trypsin, and (c) amylopsin?

(a) See second question on this page. (b) A proteolytic ferment; continues the digestion of proteids in the intestines, being active in an alkaline medium only. (c) Amylopsin is a constituent of the pancreatic juice and digests starch in the intestines. It is twenty times more powerful than ptyalin and digests raw, as well as boiled starch.

What would be the effect on the saliva and digestion if Stenson's duct should be divided?

If one of the ducts only were divided, the parotid gland of the other side would undergo compensatory hypertrophy and digestion would be but little interfered with. At first the saliva would probably be more viscid and the digestion of starches somewhat retarded. Division of both ducts would practically abolish the digestion of starch in the mouth, as only a small quantity of ptyalin furnished by the submaxillary glands would be available.

What action have atropin, pilocarpin, and nicotin upon the salivary glands and their secretion?

Atropin inhibits, and pilocarpin and nicotin stimulate the secretion of the salivary glands.

Give the number and arrangement of the temporary or milk teeth.

There are twenty temporary or milk teeth, arranged as follows: the *incisors*, four in number, occupy the center of the alveolar margins; next come the *canine* and *first* and *second molars*, in the order named.

Give the number and arrangement of the permanent set of teeth. State the particular use of each kind of teeth.

There are thirty-two permanent teeth, presenting the same arrangement as the temporary set (see preceding question), except that the deciduous molars are replaced by *bicuspids*, and there are three additional molars in each half of both jaws.

The incisor and canine teeth are used in the prehension of food, to bite off the morsel, which is then brought between the rough surfaces of the bicuspid and molar teeth for mastication.

Describe the stages of deglutition.

Buccal Stage: The mouth is closed and the jaws are pressed together by the muscles of mastication. Successive parts of the tongue, from the tip to the back, are pressed against the hard palate, forcing the bolus of food into the pharynx.

Pharyngeal Stage: Return of the bolus to the mouth is prevented by the contraction of the palatoglossus, which brings the anterior palatine arches in contact with each other, and of the styloglossus, which raises the back (base) of the tongue. The larynx is pulled upward and forward, and the glottis closed by approximation of the vocal cords (assisted possibly by the epiglottis). The soft palate is raised by the levator palati, the nasopharyngeal cavity is closed, and the bolus forced into the esophagus by the successive contraction of the three constrictor muscles of the pharynx.

Esophageal Stage: The food is forced downward into the stomach by the peristaltic contraction of the esophageal muscles. Liquids are forced through the pharynx and esophagus by the vigorous contraction of the mylohyoid muscles. The first stage is voluntary, the second and third are reflex in character.

Mention the muscles brought into action during the act of deglutition.

Orbicularis oris, muscles of mastication (masseters), mylohyoid, levator veli palati, constrictors of the pharynx, and the involuntary muscle fibers of the esophagus.

Name the muscles of mastication.

Buccinators, temporals, masseters, and internal and external pterygoids. *Accessory:* digastric, mylohyoid and geniohyoid, and platysma myoides.

Describe the physiology of vomiting.

The vomiting center is situated in the medulla oblongata. The act may be excited by irritation of the centripetal nerves of the palate, tongue, pharynx, or stomach (glossopharyngeal and pneumogastric nerves); reflexly by irritation of the uterus in pregnancy, the intestines (peritonitis), or genito-urinary tract; by the sight, smell, or taste of repulsive objects or by repulsive conceptions; and, finally, by direct stimulation of the vomiting center (apomorphin).

During the act of vomiting the walls of the stomach contract, while the cardia is held open by the contraction of the longitudinal fibers. Ejection of the contents is assisted by forcible contraction of the abdominal muscles (except in children).

In what manner, physiologically, does a largely distended stomach produce death?

A largely distended stomach produces death by the interference with digestion, causing excessive fermentation and auto-intoxication, or by pressure on the surrounding organs, interfering with their functions and with the circulation. Death may also be due to heart failure, brought on by the venous stasis which is caused by the dilatation of the stomach.

Describe the vermicular movement of the stomach and intestines. What purpose does this movement serve?

The vermicular movement or *peristalsis* of the stomach and intestines is a periodically recurring, progressive contraction of the walls, beginning (in the stomach) at the fundus and ending at the pylorus, attended by the rhythmical opening and closing of the pylorus. Each peristaltic wave lasts twenty seconds and is separated from the succeeding one by an interval of fifteen to twenty seconds. Its object is to force the gastric and intestinal contents onward and toward the arms. Pendulum-like movements also take place, moving the contents first in one direction and then in the other. Peristalsis is most marked in the small intestine; in the large bowel the movements are less active and less extensive.

Name the centers and the nerves which regulate intestinal peristalsis and describe their action.

The automatic center resides in the myenteric plexus (Meissner's plexus), which lies embedded in the muscular coat. Special nerve plexuses, containing ganglia, are found upon the blood-vessels and lymph-vessels of the intestinal walls. The nerves are the *pneumogastric* and the greater and lesser *splanchnic nerves*. The pneumogastric increases peristalsis and also contains some inhibitomotor fibers. The splanchnic is the inhibitory nerve of the intestinal movements; it also contains the nerves of sensation.

Describe the function of the ileocecal valve.

The ileocecal valve consists of two semicircular folds of mucous membrane containing circular fibers. When the cecum is distended, the valve closes and thus prevents the regurgitation of chyle into the small intestine.

Of what are the common and expected contents of the vermiform appendix composed, whether found on the dissecting-table or in the surgical operations involving that structure?

Inspissated fecal matter and fecal concretions.

Describe the muscular and nervous mechanism of defecation.

Defecation is a combined volitional and reflex act which begins with active peristalsis in the large intestine. The external sphincter, having been relaxed voluntarily, and the internal sphincter as explained in next question, a deep inspiration is taken, followed by an expiratory effort with the diaphragm fixed. The abdominal muscles are forcibly contracted, the rectum straightens out, and the soft parts of the pelvic floor are forced

downward conically, while the levator ani muscle elevates the anus, and the column of feces is expelled.

The nervous mechanism consists of the reflex anospinal center in the cord, the inhibitory center in the brain (see next question), and the sensory nerves of the rectal mucous membrane and sympathetic fibers going to and from the plexuses of Meissner and Auerbach.

Explain the action of the anospinal center in defecation.

Budge's anospinal center is the reflex center for defecation. Irritation of the sensory nerves of the rectum by the descending fecal mass causes reflex stimulation of the internal sphincter. The center for this reflex is Budge's anospinal center, situated in the lumbar cord. During defecation this reflex is temporarily abolished by the activity of an *inhibitory center* which is capable of voluntary stimulation; the latter is situated in the brain, probably in the optic thalamus, and connected with the anospinal center. During the stimulation of this inhibitory center the column of feces passes through the rectum without causing its reflex closure.

State the average weight of feces in twenty-four hours in a normal man. What proportion is made up of liquid, and what of solid contents?

The average daily quantity by weight is 170 gm. or about 6 oz. The proportion of liquid is about 75 per cent.

Give the composition of normal feces.

Water, about 75 per cent.; indigestible remains of food; hairs, horny and elastic tissue; cellulose, fruit stones, and vegetable cells; digestible remains of meat; hard albumin and starch cells; mucus, fat globules, epithelial cells from the alimentary tract, cholesterin, biliary coloring matter, fatty acid crystals; insoluble salts, especially phosphates; indol and skatol; and bacteria and yeasts.

Describe gastric digestion with special references to the changes effected upon the types of food.

The mixture of finely divided food and gastric juice is called *chyme*. As soon as the food enters the stomach certain movements are set up in the viscus: *First*, the rubbing movement, by which the walls of the stomach lying in immediate contact with the ingesta move to and fro with a slow, displacing action. These movements are periodic, each cycle lasting several minutes. *Second*, gastric peristalsis, which also recurs periodically in conjunction with the rhythmic opening and closing of the pylorus. As a result of peristalsis the chyme is, little by little, propelled into the duodenum, the first portion passing the duodenum about fifteen minutes after ingestion, and the process being completed at about the fifth hour. The secretion of *gastric juice* begins with mastication and deglutition, and is further stimulated reflexly when the endings of the sensory fibers of the pneumogastric are irritated in the stomach by the food. The conversion of *starches* into maltose under the influence of the *ptyalin* of the saliva continues in the stomach until the process is arrested by the increasing acidity of the gastric juice. There is no action on fats, but the connective

tissue is digested by the pepsin, liberating the fat-cells and preparing them for emulsification in the small intestine. The chief digestive action of the stomach is on the *proteids*. *Pepsin* in the presence of hydrochloric acid converts the proteids into *albumoses*, and finally into *peptones*. *Rennin* coagulates milk and changes caseinogen into casein.

Describe the different glands of the stomach.

The gastric glands are of two kinds: the *peptic* glands situated at or near the fundus, and the *pyloric* glands. The peptic glands (see next question) contain the chief or central peptic, and parietal or acid cells and secrete all the hydrochloric acid. The pyloric glands are not supplied with parietal or acid cells and secrete only ferments.

Describe by drawing or otherwise a peptic gland.

A simple tubular gland presenting a *duct*, a *neck*, and a tortuous or spiral *fundus*, which is sometimes divided. It has two kinds of cells, *chief* or *central* cells which bound the lumen and secrete pepsin and rennin, and *parietal* or *acid* cells, situated at the periphery of the gland, which secrete hydrochloric acid.

Give the principal characteristics of gastric juice in man.

A clear, colorless, levorotatory fluid, strongly acid in reaction, with an acid taste and characteristic odor. The specific gravity is about 1005. The daily amount is said to be about one-tenth to one-fifth of the body-weight. The normal juice contains water, mucin, hydrochloric acid, pepsin, rennin, and, possibly, some lactic acid and inorganic salts.

State the specific gravity and reaction of the gastric juice and describe its action.

See preceding question and last question on page 144.

What are the ferments of the gastric juice? Describe the action of each ferment.

See page 144, last question.

What effect have strong alcoholic stimulants on the gastric juice?

They abolish the secretion.

What prevents digestion of the stomach by its own juices?

Two factors are mentioned in explanation: (1) The alkalinity of the blood, protecting the tissues against the action of the gastric juice, which requires an acid medium, and (2) the thick, firmly adherent layer of mucus covering the walls of the viscus. With regard to the former, however, it must be remembered that the stomach has been shown to be capable of digesting parts of a living body (the leg of a frog, a rabbit's ear). All that can be said in explanation is that fully living protoplasm, hence also that of the epithelial cells of the stomach, is capable of resisting the action of peptonizing enzymes. Amebæ, bacteria, worms, and embryonal vegetable cells are not affected by artificial digestive juices.

What circumstances favor gastric digestion?

Among the many circumstances favoring gastric digestion are thorough mastication, slow eating, pleasant taste of the food, swallowing in small mouthfuls, normal amount of condiments, muscular and mental quietude, and a general healthy condition of the various parts of the body.

Give the reactions of the following fluids and state the cause of the reaction in such a case: (a) urine, (b) blood, (c) gastric juice, and (d) pancreatic juice.

(a) Acid from the presence of acid salts, especially acid sodium phosphate.

(b) Alkaline from the presence of sodium salts, especially sodium carbonate.

(c) Acid, due to hydrochloric acid.

(d) Alkaline, due to the presence of 0.4 per cent. sodium carbonate.

Discuss the action of the gastric juice on carbohydrates and fats.

The ptyalin of the saliva is active in the stomach until it reaches about 0.5 per cent. (about a half-hour after the individual has begun to eat). The small amount of mucin may ferment some of the sugars.

The gastric juice has practically no effect on fats, beyond digesting the connective tissue and setting free the fat globules.

What are the functions of the pancreas?

Besides secreting the pancreatic juice and taking a prominent part in digestion, it is probable that the gland yields a *glycolytic ferment* to the blood, which in some as yet unknown manner decomposes the sugar in the blood. This ferment is absent in diabetes (occurrence of diabetes after extirpation of pancreas).

Describe the pancreatic juice, mentioning its ferments and stating their specific actions.

An alkaline, clear, viscid, odorless, and colorless fluid containing the following ferments:

1. *Amylopsin:* converts starch into maltose and dextrin, like the ptyalin of saliva.

2. *Trypsin:* converts the abuminates into albumoses or propeptones and then into true peptones.

3. *Steapsin:* breaks up fat into fatty acids and glycerin, from which soaps and emulsions are formed. (The only fat-splitting ferment in the digestive tract.)

4. *Rennin:* like the rennin of gastric juice, except that it requires an alkaline medium.

5. *Invertin:* converts maltose into dextrose.

Define emulsification and saponification. Illustrate.

Emulsification is the breaking up of fat into very small particles and holding them in suspension in a liquid in which they will not dissolve, as mixing together oil and water.

Saponification is the replacing of the glycerin of a fat by an alkali, as the mixing of olein and sodium hydrate to form sodium oleate and glycerin.

What would be the effect on digestion if the pancreatic duct were obstructed?

As the pancreatic secretion acts on all kinds of food, this action would greatly interfere with digestion in general, especially that of the *fats* and *carbohydrates*.

Describe the portal circulation.

The blood collected from the capillaries of the spleen, stomach, and intestines by the splenic, gastric, and mesentric veins is carried by the *portal vein* to the liver. Here this vein breaks up into smaller vessels running between the lobules, called the *interlobular veins*. From these veins capillary vessels pass from the periphery of the acinus toward its center, running along the edges of the rows of liver cells. At the center these capillaries unite to form the *central* or *intralobular vein* which, after piercing the lobule, becomes the *sublobular vein* and unites with similar vessels from adjoining acini to form large trunks, the roots of the *hepatic vein*, by which the blood is returned to the inferior vena cava.

The branches of the *hepatic artery* accompany the larger branches of the portal vein and supply nutrient capillaries to the capsule, the ducts, and the branches of the portal vein.

What changes occur in the blood in its passage through the liver?

Blood going to the liver contains more proteids, fats, and organic substances; it is more coagulable; contains less sugar, extractives, and urea; and is lower in temperature than that coming from the liver.

What is accomplished physiologically by the portal circulation?

The great bulk of the products of digestion (proteids, carbohydrates, alcohol, water, and salts) are carried to the liver by the portal vein.

Name the varieties of blood that circulate in the liver. State their sources and give the destinations and functions of each.

Arterial Blood: The hepatic artery, a branch of the celiac axis, supplies numerous capillaries to the larger branches of the portal vein and to the bile-ducts. Some small capillaries pass from the periphery of the acinus into the capillaries of the portal system; others pass over into two venous trunks which empty into the portal vein.

Portal Blood: The portal blood passes from the stomach to the pancreas and spleen and brings material for the manufacture of bile and glycogen. The portal vein ultimately forms the interlobular veins. From these veins capillaries pass from the periphery toward the center, where they unite to form the central or intralobular vein, which in turn pierces the lobule vertically and at the surface becomes the sublobular vein. The sublobular veins unite to form larger trunks that represent the roots of the hepatic veins.

Venous blood is collected by the hepatic veins and emptied into the inferior vena cava at the surface of the liver.

(a) Describe bile and its uses. (b) Give a test for bile.

(a) A transparent fluid varying from yellowish brown to dark green, having a sweetish bitter taste, musk-like odor, and feebly acid or neutral reaction. Specific gravity, 1026 to 1032. (b) (See page 107, fourth and fifth questions.)

Where is the bile first formed? Trace its course.

The first biliary passages, the *bile capillaries*, originate in the center of the acinus, lying midway between two surfaces of adjacent liver cells. Leaving the acini, they unite to form larger *bile-ducts*, which finally emerge at the transverse fissure as the *hepatic duct*. The latter unites with the *cystic duct* to form the *common bile-duct*, which enters the second segment of the duodenum and is joined by the *pancreatic duct* just before its termination. The opening in the duodenum is marked by a papilla. The dilatation of the duct below the juncture with the pancreatic duct is known as the *ampulla of Vater*.

Name the bile salts and state the physiologic function of bile.

The bile salts are sodium glycocholate and sodium taurocholate (see page 107, sixth question).

Describe cholesterin, giving its origin and functions.

It appears in transparent rhomboid plates. It is insoluble in water; soluble in alcohol, ether, or chloroform. It results from the disintegration of the epithelial cells of the biliary passages and is not a secretory product of the liver.

What is the difference between Pettenkofer's reaction and Gmelin's test?

Pettenkofer's test is used to demonstrate the presence of biliary acid. The biliary acids, on the addition of two-thirds concentrated sulfuric acid and a few drops of a 10 per cent. solution of cane-sugar, yield a *purplish-red* transparent color.

Gmelin's test is used to detect the biliary pigments. The suspected material is mixed with a few cubic centimeters of nitric acid and one drop of nitrous acid, which are allowed to flow carefully down the sides of the glass without agitation; in the presence of bilirubin and biliverdin a *play of colors* results, as follows: *green*, *blue*, *violet*, *red*, and *yellow*.

What causes an increased flow of bile into the duodenum?

Reflex stimulation of the splanchnic or hepatic vessels by the entrance of food, especially proteids and fats, into the duodenum. Certain drugs, calomel, salicylic acid, olive oil, and podophyllin also increase the flow of bile.

What pathologic effects may ensue because of occlusion of the ductus communis choledochus?

Occlusion of the ductus communis choledochus produces jaundice accompanied by malaise, somnolence, headache, hard clay-colored or fatty stools, anemia, and slowing of the heart's action. It also interferes with the digestion and absorption of fats and causes constipation (see also next question).

How would digestion be affected were the ductus communis choledochus obstructed?

Large quantities of undigested fats would collect in the feces and the stools would become hard and fetid. The absorption of putrefactive products from the intestines would eventually cause death.

Describe the perversions of function that may cause icterus.

1. Obstruction to the discharge of bile into the intestine, as by a plug of mucus, gall-stones, tumors, or pressure from without, causing resorption of bile from the greatly distended bile-ducts. 2. Abnormally low blood-pressure in the state of hunger ("hunger-icterus," icterus neonatorum). 3. Excessive production of bile when erythrocytes are destroyed in excessive numbers (acute yellow atrophy and phosphorus poisoning).

State (a) the origin, (b) nature, and (c) destination of the glycogen of the liver.

(a) The carbohydrates of the food; only sugars fermentable by yeast form glycogen.

(b) Proteids, including gelatin, fats (olive oil), and glycerin. Glycogen is derived from the carbohydrate food ingested and is temporarily stored in the liver cells like starch in plants. It is an *animal starch*, therefore a carbohydrate soluble in water.

(c) It is subsequently transformed into *grape-sugar*, which is later destroyed in part in the blood on its way through the tissues, and in part by a special ferment derived from the pancreas. A portion of the sugar in the blood is converted into glycogen in the muscles.

What other substances than bile are found in the liver?

Glycogen, fats, sarcolactic acid, cholesterin, urea, uric acid, leucin and tyrosin, pigments, iron (ferratin), and inorganic salts.

Mention and describe in detail an important function of the liver other than the secretion of bile.

The production of *glycogen* (see page 96, third question).

The production of urea. A nitrogenous by-product formed from proteids while fat and glycogen are being elaborated. The quantity bears a direct relation to the quantity of proteids in the food and in the liver.

What is the physiologic function of the liver?

1. Formation of bile.
2. Formation of glycogen and fat.
3. Formation of urea, uric acid, and attendant by-products.
4. Decomposition of red blood-cells and hemoglobin.
5. Destruction of certain poisons.

What experiments have been made to prove the glycogenic function of the liver?

The blood of the portal vein during active digestion of a carbohydrate meal contains more sugar than the hepatic vein, showing the arrest of dextrose in the liver. The hepatic vein in the intervals of digestion con-

tains twice as much dextrose as that in the blood entering the liver. If a rabbit that has been fed on carrots is killed and the liver rapidly removed, cut into small pieces, and thrown into boiling water, it yields an extract rich in glycogen and almost free from dextrose. If another animal is treated in the same manner, but the liver allowed to stand for some time before making an extract, the extract will contain much dextrose, but little glycogen. Under the microscope glycogen granules are found in the protoplasm of the liver cells.

Describe the glands and villi of the intestines.

The *glands of Brunner* are short, compound, branched, tubular glands found dipping down in the mucous membrane of the upper part of the duodenum. The *crypts of Lieberkuhn* are simple tubular depressions in the mucous membrane of both the small and large intestines. They consist of a basement membrane lined with columnar and goblet-shaped epithelial cells. A *villus* consists of a mass of adenoid tissue covered with a layer of columnar epithelium resting on a basement membrane. The center of this adenoid tissue contains a small lymphatic vessel called a *lacteal.* The adenoid tissue also accommodates many capillaries which coalesce to form venules of the mesenteric veins. The large intestine does not contain lacteals.

Describe (a) chyme and (b) chyle.

(a) The mixture of finely divided food and gastric juice. A semifluid, grayish, acid substance, containing but little digested material.

(b) The fluid lymph contained in the lymphatic vessels (*lacteals*) of the digestive tract. It is alkaline in reaction and contains fats, glycerin, and lymph-cells 14 per cent. of fat, and small quantities of sugar, peptones, and salts.

State the origin and uses of the lymph.

Lymph originates in the lymph-spaces that surround the blood-vessels and unite to form the lymphatic vessels. It is derived from the blood, which contributes a modified plasma that has osmosed through the walls of the capillaries, and from the lymph-glands, which contribute lymphocytes.

Uses: 1. It conveys fluid and the products of digestion.

2. Removes effete matter from the tissues.

3. Relieves the blood-vascular system of excess of fluid.

4. Acts as a powerful solvent (hypodermic medication).

5. It is a reserve for the blood to draw on after hemorrhage or during starvation.

6. A lubricant in synovial and other fluids.

7. Takes part in the healing of wounds (glazing of the wound surface).

8. Special functions connected with the special senses (cerebrospinal fluid, lacrimal secretion, aqueous humor, etc.).

Discuss bacteria in the intestines.

Both pathogenic and non-pathogenic bacteria are found in the intestinal tract. The latter, which play a part in digestion, are schizomycetes, and excite fermentation and putrefaction. They are called *organized ferments* in contradistinction to the inorganic ferments of the digestive secretions.

The intestinal bacteria are divided into: (a) zymogenic—exciting fermentation; (b) chromogenic—producing pigments; (c) bromogenic—generating bad odors; (d) pathogenic—causing disease (Bacillus coli communis, Bacillus typhosus, etc.); and (e) toxicogenic—elaborating poisons.

Bacillus acidi lactici and Bacillus butyricus are examples of bacteria that act on carbohydrates. They convert sugar into lactic acid and lactic into butyric acid with the production of carbon dioxid and hydrogen. Other putrefactive bacteria assist in the conversion of neutral fats into fatty acids and glycerin. The bacterial digestion of proteids is slight and practically confined to the large intestine. Indol (from tyrosin), skatol (from albuminous substances), phenol, valerianic acid, ammonia, carbon dioxid, hydrogen, hydrogen sulfid, and marsh-gas are some of the products of proteolytic bacteria.

What digestive changes take place (a) in the small intestine, and (b) the large intestine?

(a) Proteids that have been acted upon by the gastric juice, and the albuminoses are converted into peptones; fats are split up and emulsified by the action of the bile and trypsin in the pancreatic juice. Undigested starch is changed to maltose, which in turn is changed into dextrose by the amylopsin of the pancreatic juice. The succus entericus probably contains an amylolytic inverting ferment which, however, has little digestive power. Its chief function is to keep the intestinal contents in solution.

(b) Microbic digestion is carried on in the lower part of the small, and in the large intestine, resulting in the formation of putrefactive products; carbon dioxid, methane, hydrogen sulfid, hydrogen, phenol, indol and skatol, valerianic acid, leucin, and tyrosin. There is but little digestion by organized ferments in the large intestine; the intestinal contents move slowly, however, and considerable absorption takes place.

FOODS

Discuss the effect of the cooking of food as a means of rendering it more digestible.

In general, cooking softens the food so that it can be masticated and more easily digested; destroys all parasites and disease germs that may be present, and develops certain flavors which increase the appetite and add to the enjoyment. It destroys the tough fibrous envelopes that surround many foods. On starchy foods cooking acts by breaking up the cellulose covering of the starch granules, so that they can be more readily acted upon by the various digestive fluids, and by changing some of the starch into dextrin. The effect of cooking on proteids is to cause coagulation and to develop savory odors and flavors from the various extractives. Proteids are not always benefited by cooking, uncooked albumin being sometimes more readily digested than coagulated cooked albumin, as, for example, in the case of eggs.

What effect does an excessive starchy diet produce?

It may cause obesity; it often produces a form of indigestion known as carbohydrate dyspepsia, characterized by gastric fermentation and flatulence. It may also lead to alimentary glycosuria.

Give the metabolism of (a) proteids, (b) carbohydrates, and (c) fats.

(a) Proteids are acted upon by the *pepsin* of the gastric juice and converted into *proteoses* and *peptones*. When the chyme reaches the small intestine, the *trypsin* from the pancreatic juice continues the process of conversion into peptones.

(b) Carbohydrates are acted upon first by the *ptyalin* in the saliva and converted into *maltose*. This action continues for a short time in the stomach until it is arrested by the acid reaction, to be resumed again in the intestine, where the chyme is acted upon by the *amylopsin* of the pancreatic juice and also by the *succus entericus*.

Fats are split up into fatty acids and glycerin and formed into soaps and emulsions. This process takes place in the intestine under the influence of *steapsin* from the pancreatic juice, assisted by the *bile*.

Into what general classes are foods divided? Give examples of each class.

(1) Inorganic proximate or alimentary principles; oxygen, water, sodium chlorid, and other inorganic salts.

(2) Nitrogenous principles—proteids and albumens, meat, eggs, and cheese.

(3) Carbohydrates—sugars, starches, and gums.

(4) Hydrocarbons—fats and oils.

(5) Condiments—spices, alcoholic beverages, tea, and coffee.

What are amyloid foods and proteid foods? Give three examples of each.

Amyloid foods are the carbohydrates, the molecule of which contains six or a multiple of six atoms of carbon, and hydrogen and oxygen in the proportion to form water. Starch, cane-sugar, and glycogen are amyloids.

Proteids are highly complex bodies containing carbon, hydrogen, oxygen, nitrogen, sulphur, and sometimes phosphorus. Egg albumen, casein, and gluten are proteids.

Name the groups of food-stuffs constituting the source of muscular energy. Designate the most important and state what stored product is utilized.

Carbohydrates chiefly. Fats and proteids may also aid in the production of muscular energy.

Glycogen is the stored product that is utilized.

Name the nitrogenous formative principles.

(a) Proteids or albuminous constituents; (b) albuminoids; (c) albuminous bodies less complex than albuminoids; and (d) iron-bearing compounds.

Name the nitrogenous proximate principles.

Albuminoids: white of egg (albumin), lean of meat (myosin), casein, and gluten of wheat.

Gelatinoids: Jellies (mucin and rerapin). They are albumen sparers.

Extractives: They stimulate the upper digestive food and produce appetite.

What are peptones? How are they formed?

Peptones are formed from proteids by the action of pepsin in the gastric juice and trypsin in the pancreatic juice. They are absorbed as peptones in the small intestine and are soluble. The intermediate product is called *albumose* or *proteose.*

Mention three examples of amyloid food. Describe in detail the changes that amyloid food undergoes in the process of digestion.

Cane-sugar, bread, and potatoes.

The insoluble starch is converted into soluble sugar, *dextrin*, which is later converted into *maltose* by the action of *ptyalin* in the mouth and stomach; uncooked starch is converted into maltose by the amylopsin in the pancreatic juice. The dextrin and maltose are later converted into *glucose* by the action of the succus entericus.

What is the function of each class of foods in the nutritive process?

The proteids build up and repair the tissues; the carbohydrates are the body fuel, being easily oxidized; the fats are not readily oxidized, but are used to form heat, the excess being stored in the adipose tissue; the salts are necessary to keep some of the proteids in solution, to regulate osmosis, to neutralize the acid produced by catabolism, and to form bone.

What special use does each of the following serve in the body after ingestion—proteids, fats, carbohydrates, alcohol, tea, and coffee?

Proteids repair the tissues; fats are used for body fuel and as a reserve; carbohydrates are the body fuel; alcohol in small doses is a general stimulant, and by stimulating the mucous membrane causes an increased flow of gastric juice. Tea and coffee are stimulants, increasing the flow of the various secretions and stimulating peristalsis.

What are the principal uses of water when taken into the body?

Water is essential to life. It is a constituent of all tissues and fluids of the body, dissolves the food, distributes the nutriment, removes waste matters, and conveys them to the organs of elimination. By evaporation it aids in maintaining the body temperature.

Describe the energy or heat-producing value of food principles.

The unit is the *calorie* or amount of heat required to raise the temperature of 1 kg. of water 1° C. The heat value of carbohydrates is equal to 4 calories per gram; fats, 8.9 calories; proteids, 4 calories per gram. If the relative proportions of alimentary principles in a given food are determined by analysis, the fuel value of the food can be calculated.

Mention four alimentary principles essential to health.

Water, salts, proteids, and one form of fat or carbohydrates.

Give the origin of normal fat in the human body and name examples of the types of food from which it is elaborated.

The normal fat of the body is derived mostly from the non-nitrogenous moiety of proteids; some from the fat ingested and some from the carbohydrates. Any excess of food is stored up as fat.

How is adipose tissue developed?

By the deposition of fat droplets in the fat-cells of the adipose tissue in the panniculus, about the viscera, and in bone marrow.

Describe the physiologic causes of obesity.

Overfeeding, especially with carbohydrates, lack of proper exercise, and certain peculiarities of the body-cells of an individual.

Give the ultimate fate of the absorbed fat.

It is burnt up into carbon dioxid and water, and is deposited in the tissues. In the blood the fat is subsequently decomposed in the presence of oxygen.

Mention the chief uses of adipose tissue.

It lubricates and prevents friction between structures in motion; protects the body against cold and mechanical injuries, gives rotundity to the figure, and provides a reserve store of nutriment and fuel.

Where is fat stored in the body?

See second question on this page.

Does alcohol possess a food action, and on what do you base your answer?

Alcohol is decomposed into carbon dioxid and water, and as it readily undergoes this decomposition, it diminishes to a certain degree the consumption of the constituents of the body. But it replaces only fat, not albumin or carbohydrates (in mixed diet). In small quantities it aids digestion and stimulates the circulation and the nervous system. It may supply food in times of temporary privation and protect the tissues of the sick from too rapid consumption.

Describe the disturbances of function produced by the excessive imbibition of alcohol.

Excessive imbibition of alcohol causes congestion of the stomach, with altered gastric secretion, precipitation of pepsin during gastric digestion, congestion of the liver, and, finally, destruction of many of the liver-cells. On entering the circulation it acts as an irritant to the whole vascular system and to the kidneys. It deranges the nervous system. It also lowers the temperature by causing peripheral congestion and consequent excessive radiation of heat.

In a healthy man, what time is consumed in the digestion of an ordinary meal of meat, vegetables, and bread?

About seven hours.

Describe the digestion in the stomach of a meal of bread and milk.

The conversion of starch contained in the bread into maltose by the ptyalin of the saliva continues for some time in the stomach. The proteid or gluten contained in the bread is converted by the pepsin into gluten peptone. The milk is coagulated and the caseinogen converted into casein by the rennin, after which the casein is changed into casein proteose and peptone by the action of pepsin. The lactalbumin and globulin are also converted into proteoses and peptones. The soluble salts are dissolved and the fats are melted.

Describe in detail the digestion of a meal consisting of bacon, eggs, and toasted bread.

See next question.

Describe in detail each step in the digestion of a meal containing proteids, carbohydrates, fats, water, and inorganic salts.

Proteids are digested in the stomach by the pepsin and hydrochloric acid, forming albumoses; and by the trypsin of the pancreatic juice into peptones. Carbohydrates are converted by the ptyalin in the saliva, the amylopsin in the pancreatic juice, and the succus entericus into maltose; the last two finish the work begun by the saliva, amylopsin being the most important ferment. Maltose undergoes a further change in its passage through the intestinal wall and in the blood. Fats are changed to fatty acids and glycerin, and form soaps, with the aid of steapsin and bile.

Water is absorbed as such in the small intestine; salts in the stomach and in the small intestine. The portal vein carries to the liver the proteids, sugars, water, and salts.

Describe the digestion of a meal of beefsteak and potatoes.

Digestion of the proteid contained in the beefsteak is begun in the stomach, where it is converted into albumose (and peptone) by the pepsin and hydrochloric acid, and continued in the small intestine by the action of the trypsin in the pancreatic juice, which converts the albumose into peptone. From the intestine the peptones enter the blood and are carried to the liver. The connective tissue of fat is digested in the stomach, and the fat droplets are liberated and then broken up in the small intestine by steapsin into fatty acids and glycerin. With the aid of the bile an emulsion is formed and absorbed by the lacteals.

Potato digestion begins in the mouth by ptyalin converting the starch into maltose, and is continued in the stomach for about fifteen minutes. In the small intestine the amylopsin of the pancreatic juice, assisted to a slight degree by the succus entericus, continues the process, and the maltose is still further changed in its passage through the intestinal wall and in the blood.

Salts are absorbed directly in the stomach and small intestine.

What is the influence of diet on nutrition?

For nutrition to go on properly, the diet must contain the various classes of foods in proper proportion. Proteids and salts are absolutely necessary. Nothing but proteids can replace the used-up proteids of the tissue. Salts

are needed especially to neutralize the acids formed during proteid catabolism and to assist in the formation of some of the secretions, like the hydrochloric acid of the gastric juice. Calcium salts are indispensable for bone formation.

What is the effect of an excessive meat diet?

An excessive meat diet disturbs the general metabolism, causing diseased conditions associated with an increase in uric acid, as gout, rheumatism, and migraine.

What would be the effect of an exclusive diet of (a) nitrogenous food, and (b) fats and carbohydrates? Explain.

(a) The breaking down of the digestive apparatus and of the kidneys. A man would have to eat 4.41 pounds of meat.

(b) Destruction of proteids and accumulation of fat in excess, with loss of strength, anemia, and diminished resistance to disease. The animal becomes fatter, but poorer in flesh.

What kinds of food would you recommend in cases of obesity?

Chief reliance should be placed on proteids, green vegetables—spinach, celery, lettuce, and the like—and fresh fruits in moderation. The whole diet, and especially the quantity of water, must be restricted. Sugars and alcoholic beverages must be interdicted and starchy foods, including oysters and liver, greatly restricted.

What precautions should be taken in the ingestion of vegetable foods? Give the reasons for taking these precautions.

Vegetable foods should be well cooked so as to burst the cellulose covering of the starch granules, and for the same reason mastication must be thorough. Some fatty food should be taken with them, as they are deficient in fats. As some vegetables contain but little nutritive material, they should be taken in relatively large quantities.

Give the relative food value and ease of digestion of meat, milk, eggs, and leguminous fruits.

According to relative food value, the order is: meat, eggs, milk, and leguminous fruits.

According to relative ease of digestion, the order is: milk, eggs, meat, and leguminous fruits.

What is the composition of human milk?

Milk contains 112 parts of solid matter to the thousand. Of these, 60 parts are the carbohydrates, lactose; 30 are fats, olein, palmitin, stearin, and butyrin; 20 are proteids, casein, and lactalbumin; and 2 parts are salts, especially sodium chlorid and calcium phosphate.

Water	87.4
Total proteid	2.3
Fat	3.8
Sugar	6.2
Salts	0.3
	100.0

ABSORPTION

What do you understand by absorption?

The process by which certain materials are taken up by the tissues or transformed by it into new substances. It is accomplished by means of *physical* and *vital* forces, the vital being primary and the physical secondary. The physical forces are *osmosis*, *filtration*, and *imbibition* or *capillarity*; the chief vital force is the *selective power of the epithelium* of the small intestine and other structures, the liver, and lymph-glands.

Mention the facts and conditions that favor absorption and those that retard it.

Concentration: Salts and sugars are absorbed in larger quantities from concentrated than from dilute solutions. The presence of certain substances, as salt, pepper, alcohol (stomach), oils, and bile (intestine) promotes absorption. *Heat* promotes, *cold* retards absorption. *Pressure:* Absorption is best when the pressure in the intestinal canal is moderate. Increased pressure causes contraction of the blood-vessels and retards absorption. *Disease:* Intestinal disease (cholera) and the presence of *poisons* that injure the epithelium of the intestinal wall retard or abolish absorption. *Experimental:* Division of the mesenteric nerve filaments and extirpation of the sympathetic ganglia of the abdomen apparently diminish absorption and cause paralysis of the intestine (not well understood).

What is meant by diffusion and osmosis? Give examples in the human economy.

Endosmosis: The process by which two miscible, dissimilar liquids, separated by a membrane, effect an interchange of their constituent parts until both liquids have the same composition. A solid substance also passes through a membrane by endosmosis if a liquid capable of dissolving it is present on the other side. Endosmosis takes place in the alimentary canal through its mucous membrane and the delicate membranes of capillary blood-vessels and lymphatics.

Diffusion, or *simple mixture*, is the interchange of particles of miscible liquids not separated by a membrane.

What is meant by endosmotic equivalent?

The figure which represents the weight of water that passes in (endosmosis) while a given weight of the substances passes out (exosmosis).

What are the channels of absorption?

The capillary blood-vessels and the lymphatics, especially the *lacteals* in the small intestine.

Describe the physiologic process by which the bite of a venomous snake or the hypodermic injection of the virus causes death.

The poison is carried by the lymphatics to the right or left subclavian vein and reaches the general circulation, by which it is distributed to the various vital organs, especially the brain, and paralyzes the respiratory or cardiac center.

Describe the structure of an intestinal villus and show how it is adapted for absorption.

A villus is a projection of all the tissues that enter into the composition of the intestinal mucous membrane. It is covered by a single layer of columnar epithelium, with intervening isolated *goblet-cells*. Protoplasmic processes resembling cilia extend into the lumen of the intestine like pseudopods, which seize the finely granular fat (chyle) and draw it into the cell body. The villus is provided with capillary blood-vessels and an axial or central chyle vessel, the *lacteal*, surrounded by adenoid tissue (Piersol's Histology, page 169).

Give the general composition of lymph, and explain why and upon what circulatory conditions the quantity formed depends.

A clear, colorless, albuminous fluid, containing lymph-cells and white blood-cells.

The quantity formed depends upon increase in arterial pressure and hyperemia of the part after digestion, the quantity of water in the blood, and the permeability of the vessel walls.

Give the origin and uses of lymph.

Lymph is diluted and modified blood plasma that has escaped from the capillaries by osmosis, containing lymph-cells (from the lymphatic glands) and white blood-cells. It supplies the tissues with pabulum and carries away waste matters. The lymph in the walls of the small intestine contains the absorbed fat and is called *chyle*. The products of some of the ductless glands are probably conveyed to the blood by the lymph.

How does the digested food enter the circulation?

Through the lacteals (lymphatics) and capillary blood-vessels.

What agencies induce the flow of lymph to the point of discharge in the veins?

The pressure within the tissues (*vis a tergo*), the contraction of the muscular tissue, and the play of the numerous valves in the lymphatics; the negative pressure within the thorax.

Describe the process of absorption by (a) the blood-vessels, and (b) the lymphatics.

The contents of the small intestine pass through the epithelium of the villi by osmosis and the vital activity (selective power) of the cells. Water, alcohol, salts, carbohydrates, and proteids enter the capillary blood-vessels and are carried by the portal vein to the liver, whence they reach the general circulation through the hepatic vein. Fats and fatty acids are taken up by the lacteals and carried to the receptaculum chyli, from which they are discharged into the thoracic duct and enter the left subclavian vein.

Mention the nutritive fluids of the body and state the functions of any one of those mentioned.

Blood, lymph, and chyle. The last is a modified lymph which passes through the lacteals in the small intestine.

Functions, see pages 129 and 150.

What substances are absorbed principally (a) in the stomach, and (b) the duodenum?

Stomach: alcohol, salt solutions, and, to a less degree, albumoses and peptones.

Duodenum: carbohydrates, fats, albumoses and peptones, glucose, water, and salts.

Give the relative activity of absorption in the alimentary canal, the skin, and the lungs.

Lungs, alimentary canal, and skin, in the order named.

Define and differentiate secretion and excretion.

Secretion is the elaboration and separation of certain fluid or semifluid substances by glandular epithelium. It is the function of the glands and follicles. *External* secretion: discharge on a free epithelial surface communicating with the exterior. *Internal* secretion: discharge into the blood or lymph (glucose—ductless glands).

Excretion: the separation of the waste products of an organ, or of the body as a whole, out of the blood.

Name two circumstances influencing secretion.

Reflex nervous stimulation and an adequate supply of blood to the gland.

Give the elementary structure of all secreting glands, and describe the changes that take place during secretion.

All secreting glands consist of two fundamental parts: a *fundus* or deep secreting portion, and a *duct* or superficial portion through which the secretion reaches the surface. During rest the cells of the acini become distended with the product of the gland and the nuclei are crowded to the periphery. After active secretion the cells appear shrunken, and the protoplasm and nucleus are more distinct. The blood-supply of a secreting gland is increased during its activity.

Define and illustrate (a) simple tubular glands, (b) compound tubular glands, and (c) racemose glands.

(a) A *simple tubular* gland consists of a single straight or tortuous fundus, lined with spherical or polygonal secreting epithelium, and an excretory duct, the lining cells of which are practically the same as those of the adjacent mucous membrane. *Example:* peptic glands and glands of Lieberkuhn.

(b) In *compound tubular* glands the fundus is *divided* into two or more slightly expanded divisions opening into a common duct. *Example:* pyloric glands of stomach, kidney, and liver.

(c) *Racemose Glands.*—The fundus is represented by a *cluster of acini,* and the secretion is conveyed by a system of branching excretory ducts consisting of the following parts: *intermediate tubules*, each communicating with several adjacent acini; *intralobular tubes*, *interlobular tubes*, *interlobular ducts*, and *excretory ducts*, which latter usually unite to form a single *common duct* of large size. *Example:* salivary glands and pancreas.

Describe gland secretion as illustrated by the action of the parotid gland.

In response to stimulation of the secretory nerves the epithelial cells of the gland discharge their contents into the excretory duct. Glandular activity is accompanied by, but not dependent upon increased vascularity of the gland. Histologic changes take place in the gland cells during secretion, proving that they take an active part in the process. In the case of the salivary glands, mucin and ptyalin do not occur in the blood and must, therefore, be formed within the gland cells.

The presence of food in the mouth stimulates the sensory endings of the lingual and glossopharyngeal nerves and sends afferent impulses to the reflex center in the medulla, which stimulates the motor cells of the cranial secretory fibers. The center may also be stimulated through other paths, the endings of the pneumogastric in the stomach, the uterine nerves, and cerebral fibers (the thought of savory viands induces a flow of saliva). In the case of the parotid gland the secretory impulses reach the gland through the nerve of Jacobson or the tympanic branch of the glossopharyngeal.

Describe an epithelial secreting surface.

The mucous membrane of the *stomach* is covered with columnar epithelium and presents, in addition to the folds or rugæ, the openings of the gastric glands, appearing as minute depressions. The mucosa is supported on a layer of connective tissue which contains involuntary muscle fibers, blood-vessels, and lymphatics (the submucous, muscular, and serous coats). The glands are entirely contained within the mucous coat. (For description of gastric glands, see page 145, first question.)

Explain the anatomic and physiologic difference between mucous, serous, and synovial membranes.

A *mucous membrane* is a secreting surface covered with epithelium and usually provided with glands. It consists of a connective-tissue *stroma* or tunica propria, a *basement membrane* or membrana propria, and the *epithelial covering*. All cavities and passages communicating with the air are lined with mucous membrane.

Serous membranes form the lining of all cavities cut off from the atmosphere and form part of the lymphatic system. They consist of a single layer of *endothelial cells* resting on a connective-tissue *stroma*.

Synovial membranes are modified serous membranes that form the linings of the synovial capsules of joints, tendon sheaths, and bursæ. They secrete a glairy, viscid fluid for the lubrication of opposed articular surfaces.

Name seven secretions and name the functions of each.

1. Milk. To provide nourishment for the young.
2. Saliva (see page 141).
3. Gastric juice (see page 145).
4. Pancreatic juice(see page 146).
5. Bile (see page 148).
6. Sweat. Elimination and heat regulation (see page 166).
7. Prostatic fluid. Dilutes and furnishes motor stimulation to spermatozoa.
8. Synovial fluid (see preceding question).

What is the difference between secretion and excretion in glandular function? Give an illustration of each.

Secretion is the production of a substance or fluid used in the body economy. *Examples:* saliva, digestive ferments, sweat, mucus, and synovial fluid.

Excretion is the separation of used-up or effete materials from an organ or from the body. *Examples:* urine, feces, and sweat.

Name the excretory glands of the body and the function of each.

The *kidneys* excrete urine; the *sweat-glands* eliminate waste materials in the sweat and help to regulate the heat of the body; the *liver* disposes of some effete matter, disintegrated blood-cells, and certain poisons.

Through what mediums is the blood relieved of effete matter and provided with new material?

The capillaries and lymphatics both carry away effete matter and supply the blood with pabulum. The liver and spleen dispose of the dead blood-cells. The lungs provide the blood with oxygen and eliminate the carbon dioxid.

Name the excretions of the body.

Urine, feces, sweat, and carbon dioxid.

What physiologic laws are the basis of rectal feeding in disease?

The laws governing digestion and absorption. The large bowel is practically without digestive activity, but absorption takes place through its walls to a considerable degree, and fluid injected slowly into the rectum may at times pass beyond the ileocecal valve. Nutritive enemata should be liquid and should contain principally nitrogenous substances—eggs, milk, and meat—predigested by peptonization and by the addition of pancreatin.

METABOLISM

What is metabolism?

The power possessed by all living organized bodies of continually using up and renewing by chemical processes the matter composing their bodies. The process of building up is called *anabolism* or assimilation; the process of breaking down *catabolism*.

The *objects* of metabolism are to build up new tissue and repair loss; to store up food material and fuel, to transform the food into heat and energy, and to prepare the excrementitious matters. The *chemical changes* consist in hydration, dehydration, reduction, and oxidation.

Name the inorganic proximate principles that enter into the formation of the human body.

Water and the various salts, as sodium chlorid, potassium sulfate, calcium fluorid, and magnesium phosphate.

What do you understand by the term nutrition, and what processes are comprised under it?

By nutrition is meant the taking in of nutrient material, its conversion into living protoplasm, and the throwing off of waste matter from the cell. It includes digestion, absorption, metabolism, and excretion.

Define (a) secretion, (b) excretion, (c) protoplasm, and (d) assimilation.

(a) A product of glandular activity needed in the various processes of living organism.

(b) A product of glandular activity containing waste of no further use to the organism.

(c) The material which constitutes the substance of living plant and animal cells and surrounds a specially formed element, the nucleus.

(d) Assimilation is the conversion into the tissues of substances obtained from the food.

What influence has the nervous system on the process of secretion?

The nervous system controls the process of secretion by the various secretory centers and nerves, and by regulating the blood-supply of the various organs of the body.

How are (a) the proteids, (b) carbohydrates, (c) fats, and (d) salts utilized in the process of metabolism?

(a) The proteids are used in building new tissue and repairing loss.

(b) and (c) The carbohydrates and fats supply most of the heat and energy.

(d) Salts are needed in various ways, especially to combine with the sulfuric and phosphorous acids formed in proteid catabolism.

Describe fat and tell where it is found.

Fat at the temperature of the living body is a liquid, consisting of *palmitin*, *stearin*, and *olein*. It is found in adipose tissue, fat-cells united by connective tissue, which is widely distributed in the body, especially under the skin and around the viscera.

State the function or functions of (a) bilirubin, (b) hemoglobin, (c) myosinogen, (d) fibrinogen, and (e) caseinogen.

(a) Gives the yellowish-brown color to the bile—a derivative of hemoglobin.

(b) The coloring matter of the blood; conveys oxygen to the tissues.

(c) A constituent of muscle tissue coagulating at 55° C. and forming myosin.

(d) The soluble albumin of blood plasma. It is converted into fibrin by the action of fibrin ferment or thrombin (see page 129, first question).

(e) A proteid constituent of milk which, when acted upon by rennet, produces casein. It is analogous to myosinogen and fibrinogen.

Describe cholesterin, giving its origin and function.

Cholesterin is a monatomic alcohol, a normal ingredient of nerve tissue, and thrown off in small quantities from the body in bile, being a product of disintegration. It is probably a waste product of nerve tissue and of the epithelial cells of the biliary passages.

Define leukomain.

Leukomains are alkaloidal or basic substances formed in the living tissue by metabolism, waste in nature. Some leukomains are toxic.

What are ptomains, and how are they produced?

Alkaloidal substances resulting from the decomposition and putrefaction of albuminous (animal and vegetable) materials. Some are poisons, the greater number are not. Directly or indirectly they are dependent upon bacterial activity—"transition products—the process of putrefaction," and found in a variety of animal and vegetable foods.

What is meant by metabolic equilibrium?

That normal condition in which precisely the same quantity of material is taken up and assimilated from the digested nourishment as is removed from the body through the excretory organs in the form of waste materials or end-products of retrogressive tissue metamorphosis. The income must balance the expenditure.

What becomes of the nitrogen ingested with the food?

Almost all is excreted in the urine in the form of urea; about 2 per cent. as uric acid and creatinin, and from 4 to 5 per cent. in the feces. Traces escape with the expired air.

Mention four necessary constituents of a normal diet.

(1) Water; (2) salts; (3) proteids; and (4) fat or carbohydrates.

What proportion of nitrogenous and non-nitrogenous elements in the diet is most advantageous?

One nitrogenous to four parts of non-nitrogenous elements.

Why is it impossible for man to subsist on an exclusive meat diet?

To obtain the number of calories necessary for his daily needs he would have to consume a larger quantity of meat than his digestive organs could cope with.

What is meant by internal secretion?

The production by certain organs of substances that enter the circulation and influence metabolism either by manufacturing an antidote or in some other unknown manner.

Mention some of the organs that are thought to furnish an internal secretion.

The adrenal bodies, the thyroid and thymus glands, the pituitary body, the liver, the kidneys, the testicles, and the ovaries.

In what glands of the body is the function undetermined?

Except that they are probably in some way concerned with general metabolism, the functions of the following glands are undetermined: pituitary body, thymus, and coccygeal gland. But little is known about the adrenal bodies and thyroid gland.

Give the physiology of (a) hunger, and (b) thirst.

Hunger is the constitutional need of the body for food, manifesting itself by symptoms referred to the epigastrium. The impoverishment and changes in the blood so affect the central nervous system as to cause the sensation.

Thirst is the constitutional need of the body for water, with localized symptoms in the pharynx. The lack of water in the blood so affects the nervous system as to cause this dryness of the throat.

ANIMAL HEAT

What are the sources of animal heat?

The chemical action involved in the oxidation or combustion of food.

Muscular and visceral activity (digestion, muscular and mental work, and circulation of the blood) are attended by the production of heat.

Give the normal temperature of the body.

98.6° F.

In the axilla	37° C.	98.6° F.
In the mouth	377.2° C.	98.9° F.
In the rectum	38.01° C.	100.4° F.
In the vagina	38.03° C.	100.45° F.

—(Landois).

What is the cause of the post-mortem rise of temperature sometimes observed?

Coagulation of the blood and myosin—rigor mortis—and persistence of metabolic activity (growth of hair); diminished radiation on account of cessation of circulation.

What conditions produce variations in the normal temperature of the body?

Age: Highest in the newborn and aged (see page 165, first question).

Season: 0.1° to 0.3° C. lower in winter than in summer in the temperate zone.

Climate: Very slightly (0.5° C.) higher in the tropics than in the temperate zone.

Digestion: Increased metabolism and muscular movements of viscera cause a slight increase.

Time of Day: Highest between 5 and 8 P. M.; lowest between 2 and 6 P. M.

Exercise: Causes a slight increase.

Hemorrhage: Reduces the body temperature from 9.5 to 2° C.

Venesection: Fall followed by rise and chill.

Hypodermoclysis and *transfusion* are followed by a rise of temperature.

Poisons: Chloroform, chloral, anesthetics, alcohol, digitalis, quinin, and

acetanilid lower the temperature. Nicotin, strychnin, picrotoxin, and veratrum viride cause elevation.

Shock causes a lowering of the temperature, followed by a reactive rise above normal.

Paralysis is sometimes accompanied by a reduction of temperature.

Give the difference between the temperature of a newborn child and that of an adult. Between the temperature of a person intoxicated by alcoholic drink and his temperature after the first stimulating drink of liquor.

Immediately after birth the temperature is somewhat above normal—0.3° C.—but soon declines about 0.9° C. and becomes subnormal. After from nine to thirty-six hours it again reaches normal and remains so. The average temperature of an infant is 37.45° C. (99.4° F.).

Large doses of alcohol, as in intoxicated persons, cause a subnormal temperature (congestion of peripheral vessels and increased radiation; loss of vasomotor tone); a small dose is followed by a slight rise of temperature (stimulation of heart action and more active circulation).

Mention some of the conditions affecting heat production.

Age: Young animals produce more heat in proportion to their weight because of the relatively larger body surface and of their greater metabolic activity (growth).

Sex: Less in women than in men.

Species: The smaller the species, the greater the amount of heat produced per kilo of body-weight.

Temperature: Increase of body temperature increases heat production; increase of external temperature decreases heat production.

Digestion: Increases heat production on account of the chemical changes and vascular activity involved.

Drugs: Cocain increases, narcotics lessen heat production.

How is normal body temperature regulated and sustained?

It is regulated chiefly by the nervous mechanism of heat or *thermotaxis*. There are *thermogenic* and *thermolytic* centers. The principal thermogenic centers—automatic, reflex, or general—are found in the cord, probably in the anterior horn. The thermolytic centers are five in number: *vasomotor*, *sweat*, *respiratory*, *cardiac*, and *pilomotor*. Dissipation of heat is effected by dilatation of the surface vessels, increased sweat production, acceleration of the respiration, and the raising of the hair or feathers (in animals). Sweating is probably the most important factor in heat dissipation. (For Heat Production, see page 164.)

What variations of temperature are found in the different parts of the body? Mention the reasons for such variations.

The highest temperature is found in the blood of the hepatic vein and is due to the amount of heat formed in the liver. The tip of the nose is said to be the coldest part of the body, due to its exposed position and to the thinness of its walls. The skin is always cooler than the internal organs, partly on account of the radiation of heat from the blood-vessels of the skin, and partly on account of the increased heat production in the internal organs.

FUNCTIONS OF THE EXTERNAL INTEGUMENT

Mention the glands of the skin and give their functions.

1. *Sebaceous*. Secrete sebum, which keeps the epidermis and hair pliable and prevents maceration and excessive desiccation. Varieties of sebum: *vernix caseosa*, covering the body of the newborn; *preputial smegma; cerumen* (ear-wax); and the *secretion of the Meibomian glands* (cutaneous fat).

2. *Sudoriferous*. Secrete sweat (see third question on this page).

What are the functions of the skin and its appendages?

1. *Integumentary* and *protective*. It protects the underlying tissues against undue pressure and external mechanical injuries. The pressure exerted on the cutaneous vessels prevents excessive loss of fluid from these vessels. When dry, the skin is a poor conductor of electricity. It prevents the absorption of poisons and keeps adjacent parts from growing together. The hairs serve as tactile organs—eyelashes and lanugo hairs of the face. Being a poor conductor, the hair of the scalp, besides affording protection against rain and external mechanical injuries, assists in regulating animal heat by taking up and giving off heat, and affords protection against direct radiation from the sun.

2. The *respiratory* function of the skin is of minor importance. About one-sixty seventh of the body-weight is lost through the skin, mostly by evaporation of water. Some carbon dioxid is excreted, and about an equal quantity of oxygen is absorbed. The skin excretes only one-two hundred and twentieth as much carbon dioxid as the lungs, and absorbs about one-eightieth of the quantity of oxygen absorbed by the lungs.

3. *Secretory* (see next question).

(a) What matters are excreted by the skin? (b) How may the functions of the skin be affected as to the amount of excretion?

(a) Water, carbon dioxid, nitrogen in the form of urea in the sweat, and in desquamated epidermal structures (hairs and nails); sodium chlorid and other alkaline chlorids; and traces of sulphur.

(b) (1) *Factors that increase the secretion of sweat:* (a) elevation of surrounding temperature; (b) ingestion of water, especially hot water; (c) muscular and cardiovascular activity (nitrogen also increased); (d) elevation of body temperature; (e) certain drugs: pilocarpin, physostigmin, strychnin, picrotoxin, nicotin, and camphor; and (f) stimulation of the sweat center, as by the presence of carbon dioxid in the blood, by overheating the blood, and by poisons.

(2) *Factors that diminish or suppress the secretion of sweat:* (a) cold and very high temperatures—above 50° C. (122° F.); (b) increased urination and defecation (dry skin in diabetes; development of uremic state in cholera).

What is the composition of sweat?

Water, 991 parts in 1000; solids 8.5. *Organic:* neutral fats—palmitin, stearin, cholesterin; volatile fatty acids; formic, acetic, butyric acid; traces of albumin; urea (0.1 per cent.); uric acid; and ammonium salts. *Inorganic:* sodium chlorid, potassium chlorid, sulfates; traces of earthy phosphates and sodium phosphates; and carbon dioxid and nitrogen.

What are the uses of perspiration?

1. Excretion of certain substances.
2. Heat regulation by evaporation.
3. Keeps the skin moist.

What relation does the nervous system bear to the excretion of perspiration?

The secretion of sweat is controlled by (a) *vasomotor* and (b) *sweat* fibers. As the two kinds of fibers pursue almost identical paths, increased sweating is usually associated with vasodilation. After division of the cervical sympathetic, unilateral sweating is observed. The sweat centers in the medulla, which probably have the same distribution as the vasomotor centers, may be irritated by overheating of the blood; the accumulation of carbon dioxid; and the presence of other poisons in the blood; irritation of sensory nerves; excessive heating of the skin; stimulation of gustatory fibers (localized sweating on the forehead and under the eyes after eating acid substances).

MOTOR APPARATUS

Describe the structure of (a) striated muscle, and (b) non-striated muscle. Which of these is voluntary and why?

(a) A *striated* muscle is covered by a connective-tissue sheath, the *external perimysium*, from which septa extend into the interior of the muscle and form the *internal perimysium*, carrying vessels and nerves and dividing the muscle into bundles of fibers. The individual fibers, varying in length and thickness from 5.3 to 9.8 cm. and 10 to 100 μ respectively, are enclosed in a structureless, transparent sheath, the *sarcolemma*, and exhibit *transverse striations* at intervals of 2 to 2.8 μ. In addition there is a longitudinal striation due to the fact that the fiber is made up of numerous delicate, primitive fibrils. Each separate fibril is striated transversely and all are bound together by a cement substance—*sarcoplasm*. The fibril has a columnar structure and is made up of numerous muscular elements superposed in layers. Muscle fibers contain several longitudinal nuclei surrounded by a thin layer of sarcoplasm and called *muscle corpuscles*. One or two *nucleoli* are found in each nucleus.

Striated muscle is called voluntary because it is under the control of the will.

(b) *Nonstriped* or smooth muscle consists of small, unicellular, spindle-shaped fibers not surrounded by sarcolemma and exhibiting faint, longitudinal, but *no transverse striation*. The fibers are sometimes forked (heart) and the rod-shaped nucleus is situated at the center of the fiber.

How do the striped and unstriped muscular fibers differ in response to stimuli?

Unstriped muscular fibers are much slower in response.

Name some of the involuntary muscles and the function with which each is concerned.

The *uterus* is the organ for the carrying of the developing embryo and fetus. The muscle is used for the expulsion of the fetus at the end of intra-uterine life.

The muscular wall of the *intestines* is used for mixing and passing on the food received from the stomach.

The tunica media of the *arteries* contains many muscular fibers that control the supply of blood to the various parts of the body.

Describe the changes in form, volume, and physical and chemical properties occurring in the contraction of a muscle.

The muscle becomes shorter, but the volume remains the same. It becomes *acid* in reaction, more oxygen is used up, and more carbon dioxid given off; *glycogen* is used up, and the muscle substances soluble in water are diminished, while those soluble in alcohol are increased.

Define (a) tonic muscular contraction, and (b) clonic muscular contraction. Give an example of each.

A *tonic* muscular contraction is continuous, as the action of the sphincter ani and other sphincter muscles.

Clonic muscular contraction is intermittent or remittent, like the jerking movements in a (clonic) convulsion.

What stimuli produce muscular contraction? What is the nervous mechanism of muscular contraction? Illustrate.

Stimuli producing muscular contraction are: normal (voluntary), chemical (automatic movements), thermal (reflex excitation), mechanical, and electric.

Nervous mechanism of muscular contraction. The motor impulse starts from the motor nerve-cell, passing down the motor neuraxon to the motor end-plates, where the muscle-cells are stimulated to contract. One stimulus would simply cause a muscular twitch, but normally in a muscular act a series of impulses is sent from the nerve centers to keep the muscles in a voluntary tetanus. *Example:* In raising the foot the motor impulse starts in the cerebral grey cells of the Rolandic area, passes down to the cells in the anterior horn of the opposite side in the lumbar cord, then out through the sciatic nerve to the motor end-plates of the muscles required to lift the foot, which in turn stimulate the muscular fibers.

Define electrotonus, and explain the law of contraction operative when a closing and opening current is applied to the muscles.

If a living nerve is traversed throughout a definite length by a constant electric (polarizing) current, the muscle passes into a condition of altered irritability designated *electrotonus*. At the positive pole or anode the irritability is diminished and *anelectrotonus* prevails. At the negative pole or cathode it is increased—*catelectrotonus*.

1. On closing the circuit stimulation occurs only at the cathode at the moment when catelectrotonus develops. 2. On opening the current stimulation takes place only at the anode at the moment when anelectrotonus disappears. 3. The stimulus attending the development of catelectrotonus is stronger than that caused by the disappearance of anelectrotonus.

What is meant by the condition of tetanus in a muscle?

When a muscle goes into a state of continued contraction it is said to be tetanized.

Give the causes of muscular fatigue.

Accumulation in the muscular tissue of the products of metabolism or *fatigue bodies*, which are formed as a result of muscular activity—phosphoric acid, acid potassium phosphite, and carbon dioxid. Fatigue can be removed by washing away the substances by the passage of normal salt solution or the injection of arterial blood into the vessels. An animal may be fatigued by transfusion of blood from a completely fatigued animal.

What is rigor mortis?

Rigor mortis is the post-mortem rigidity of the muscles due to the coagulation of the myosin in the muscle fibers, with the production of heat and lactic acid.

What is the order of occurrence of rigor mortis in the different parts of the body?

Rigor mortis usually begins in the muscles of the eye, passing to the jaw and neck muscles, and in turn, to the chest, arms, abdomen, and lower extremities. The onset of rigidity is always preceded by a disappearance of nervous activity; hence, the muscles of the head and neck are first affected and then the others in descending order.

Give the function of the epiglottis.

Assists in preventing the entrance of food into the larynx during deglutition and influences the *timbre* or quality of the voice (clear or muffled); it does not affect pitch.

Describe the position of the vocal cords during phonation and name the factors concerned.

The chink of the glottis during phonation is narrowed, the arytenoid cartilages are approximated, and the vocal cords are stretched. The arytenoid muscle approximates the arytenoid cartilages and, with the help of the lateral crico-arytenoids and the internal part of the thyro-arytenoids, closes the glottis. The vocal cords are made tense by the cricothyroids and external part of the thyro-arytenoids.

Define stammering and state what causes it.

Stammering is a defect of speech due to the spasmodic action of the diaphragm interrupting the flow of air past the vocal cords. The larynx and lips are under control.

Define aphonia and aphasia. Give the cause of one of these conditions.

Aphonia is the loss of voice or power of phonation. It is due to paralysis of the motor nerves of the larynx, wounds, tumors, aneurysm, rheumatism, overexertion, hysteria, or edema of muscles.

Aphasia is the inability to give the proper word symbol. Motor aphasia is due to a lesion of the left lower frontal convolution or of the fibers coming from it.

How are the phenomena of ventriloquism produced?

Instead of the usual expiratory blast, an inspiratory blast is used in producing the vocal sounds. At the same time the operator diverts the attention of the onlookers to some distant object.

What is the location of the center for articulate speech?

The center for articulate speech is in *Broca's convolution*, the left lower frontal in right-handed people.

What causes the difference in pitch between male and female voices? What causes the voice of the youth at the period of puberty to "crack"?

The pitch is inversely proportional to the length of the vocal cords; it is, therefore, higher in women and children than in men.

The cause of the cracking of the voice at puberty is the change of the childish treble to the lower-pitched adult voice, during which now and then a treble tone creeps in.

How are the vocal sounds produced?

By vibration of the true vocal cords in the larynx, brought about by the current of expired and, under certain circumstances, inspired air. The modifications of the voice are effected by the peculiarities and arrangement of the cavities above the larynx—the mouth, pharynx, and nasal cavities—which act as "reinforcing tubes."

THE SECRETION OF URINE

Describe the function of the kidneys. Do both kidneys act constantly? Explain.

The function of the kidneys is to remove from the blood water and certain waste substances, especially urea and uric acid, which pass out of the body in the urine. The secretion from the two kidneys is not constant or uniform, the condition is one of alternation between activity and hyperemia. One kidney may secrete urine containing a large quantity of water, salts, and urea, and of a higher degree of acidity than the secretion of its fellow. Extirpation or functional loss of one kidney does not diminish the secretion, as the other kidney undergoes compensatory enlargement and its activity is increased to supply the extra demand on the secretory structures.

How does impairment of the function of the kidneys affect that of the skin and lungs?

The activity of the sweat-glands is increased and the excretion may contain urea and uric acid. The odor of the breath becomes urinous; dyspnea, asthmatic attacks, and, at times, Cheyne-Stokes breathing and pulmonary edema develop.

Give the minute structure of the kidney.

The kidney is a compound, tubular gland consisting of an outer portion, or *cortex*, and a central striated portion, or *medulla*, occupying two-thirds of the gland. The cortex contains the *Malpighian bodies*, each of which

consists of a convoluted mass of capillary blood-vessels, the *glomerulus*, and the surrounding *capsule of Bowman*. The glomerulus has an afferent artery and an efferent (arterial) vessel. The *uriniferous tubules* begin in the cortex as the capsules of Bowman and terminate as the *excretory ducts* or tubes of Bellini in the papillæ of the medullary portion. Their orifices are recognizable by the naked eye. The uriniferous tubules undergo several changes in size and shape during their tortuous progress through the kidney substance, the successive portions being: capsule of Bowman, neck, proximal convoluted tubule, spiral portion, descending limb, Henle's loop, ascending limb, irregular tubule, distal convoluted portion, arched collecting tubule, straight collecting tube, excretory duct or tube of Bellini (see Huber's Histology, page 323).

State the function of (a) the vas deferens, (b) the vesiculæ seminales, and (c) the prostate gland.

(a) The vas deferens is the excretory duct of the testicle.

(b) They act as reservoirs for the seminal fluid, to which they contribute a secretion of their own.

(c) The prostate gland, a musculoglandular organ, secretes a thin, milky fluid which assists in diluting the seminal fluid and probably furnishes to the spermatozoa the motor stimulation essential for impregnation. In its character as a muscular organ it acts as an involuntary sphincter of the bladder. The prostate is also thought to produce an internal secretion.

Describe the renal circulation.

The renal artery enters the kidney at the hilus and at the juncture of the cortex and medulla divides into the *cortical branches* and the *arteriæ rectæ*, which supply the tissues of the medullary portion. The cortical arteries supply the *afferent vessels* of the glomeruli, which form the groups of convoluted capillaries characteristic of these structures. The glomerular capillaries unite to form the *efferent vessels* (conveying arterial blood) which, after leaving the Malpighian bodies, break up into a second set of capillaries surrounding the convoluted tubules. These capillaries are taken up by the *interlobular veins*, which pass to the pelvis and aid in forming the large *renal veins*. The blood from the peripheral portions of the cortex is collected by the *stellate veins* and also escapes from the kidneys in the renal veins.

State the influence of the blood circulation on the secretion of urine. Explain the effect of division of the renal nerves on the secretion of urine.

Increased cardiac activity, causing increased blood-pressure and velocity of the current, augments the quantity of urine; stimulation of the vasomotor center has the same effect. Conversely, weak heart action (myocarditis, valvular lesions) and vasomotor paralysis diminish the urinary secretion. If the increase of blood-pressure is excessive, albumin may pass into the urine.

Division of the renal nerves, which have a vasoconstrictor action, is followed by engorgement of the renal vessels and increased urination or polyuria. If the increase in pressure is very great, albuminuria is produced, and rupture of the globular vessels may be followed by hematuria.

State the accepted theory regarding the mechanism of the secretion of urine.

The secretion of urine depends partly on the blood-pressure and partly on the functional activity of the epithelium lining the urinary tubules and the glomeruli. The urinary water is secreted principally in the glomeruli, and its quantity depends chiefly on the blood-pressure; the specific urinary substances (urea) are removed from the blood by the epithelial cells of the convoluted tubules. No secretory nerves have been demonstrated in the kidneys, which seem to be controlled by the vasomotor system. There is some evidence that the kidneys also possess an internal secretion.

Describe the physical properties of healthy urine.

A straw-colored or amber, clear liquid, acid in reaction, with a specific gravity of 1015 to 1025. The taste is saline and bitter, the odor characteristically aromatic or "urinous." A slight sediment collects on standing.

Give the variations within the limits of health in the specific gravity of urine.

1002 to 1040. The minimum is observed after copious drinking, the maximum after profuse sweating and great thirst.

What is the composition of urine?

Urine is composed of 96 per cent. water and 4 per cent. solids, one-half of which is urea. The other half is made up of phosphates (earthy and alkaline), sulfates of sodium and potassium, chlorid of sodium, uric acid, hippuric acid, extractives, and the coloring matters—indican, urobilin, and urochrome.

Give the normal constituents of the urine.

Water. *Organic:* urea, uric acid, creatinin, alloxuric bodies, and hippuric acid. *Inorganic:* sodium chlorid, potassium, and sodium sulfates, indican (conjugate and ethereal sulfates), earthy and alkaline phosphates, acid phosphates, sometimes carbonates and oxalates (calcium). *Coloring matters:* urobilin, urochrome, uro-erythrin, and uromelanin.

Name the solids in the urine and state the approximate amount of each voided daily by an adult.

Urea, 500 gr.; chlorid of sodium, 180 gr.; sulfates (sodium and potassium), 30 gr.; phosphate (earthy and alkaline), 45 gr.; uric acid, 7 gr.; hippuric acid, 7 gr.; and small quantities of various pigments and other organic matter.

What conditions increase the amount of solids in the urine?

Physical exertion, increased ingestion of salts, fever, diarrhea, free perspiration, limiting the quantity of fluid ingested (relative increase), and diabetes mellitus (1030 to 1060).

Describe urea, its occurrences, variations in the quantity excreted, and recognition in the voided urine.

Urea, $CO(NH_2)_2$, is a crystallizable substance soluble in alcohol and water, almost insoluble in ether, and neutral in reaction. Urea occurs in the liver, the principal seat of its formation; the intestines; also the blood,

lymphatic glands, spleen, lungs, brain, etc. The daily quantity is from 30 to 40 gr. (between 2.5 and 3.2 per cent.), and varies with the amount of nitrogenous food in the diet and the disintegration of the nitrogen-containing tissues in the body. It is increased also by exercise. (For the recognition of urea in the urine see under Chemistry, pages 114 and 115.)

How is uric acid developed in the human system? What class of foods increases the development of uric acid.

From the nuclein of the disintegrating leukocytes. In general all nuclein-containing foods, such as cheese, salt fish, or salt meat.

Where is the vesical center located?

The *vesicospinal center* for reflex stimulation of the smooth muscle of the bladder is situated in the spinal cord, in the neighborhood of the fourth lumbar vertebra.

Describe the mechanism of micturition.

Irritation of the sensory nerves of the bladder, when it is moderately distended, excites in the vesicospinal center the reflex through the motor nerves of the bladder, which causes contraction of the walls and expulsion of the contents, after the sphincter of the urethra has been voluntarily inhibited. Evacuation is aided by voluntary contraction of the abdominal muscles, and in men, toward the end of the act, of the bulbocavernosus muscle (accelerator urinæ). The reflex may also be excited by irritation of other sensory nerves (tickling or warming the region of the knee, hearing the sound of running water).

THE NERVOUS SYSTEM

Define life and death.

Life is the sum total of vital activities—(a) sustentative, (b) correlative, and (c) generative. Death is the cessation of all vital activities.

Give a physiologic explanation of (a) sleep, and (b) dreams.

(a) When the potential energy in the nerves, especially the central organs, has been consumed, restitution becomes necessary and sleep is induced probably by the accumulation of decomposition products in the body.

(b) Toward the period of awakening, the psychic activities may reappear in the form of dreams, consisting either of hallucinations, visions without any objective cause, or perverted volitional impulses or conceptions.

What is the condition of the brain during sleep?

The brain during sleep is in a condition of partial anemia, the general blood-pressure being lowered. All psychic activities are abolished.

Enumerate the physiologic advantages of natural sleep and state at what period of life the least sleep is required.

(a) The fall in the blood-pressure and the relaxation of the vasomotor tone, aided by the recumbent position, insure the most complete rest for the heart. All the tissues of the body, especially the nervous tissues, have an opportunity to recuperate, and waste matter is carried off.

(b) It is during adult life that the least sleep is required.

Define somnambulism from a physiologic point of view.

A persistence of the primitive states of consciousness, the ordinary motor functions, after the higher conscious states—judgment and inhibition—have been abolished by natural or artificial means (sleep).

What is hypnotism?

Hypnotism is that branch of mental science which deals with the phenomena of hypnosis and the methods for its induction. *Hypnosis* is a subjective condition of the mind in which the normal influence of judgment and volition is restricted or abolished, while the susceptibility to suggestion is enormously increased. The subject's mind is subordinated to that of the operator and is said to be *en rapport*.

Describe nerve-cells and fibers.

Nerve-cells or *neurons* are nucleated masses of granular protoplasm, with one or more protoplasmic prolongations called *dendrons*. Most nerve-cells are supplied with a long fiber or *axis cylinder*.

Nerve fibers are medullated or nonmedullated:

(1) The *non-medullated, gray* fibers are surrounded by *neurilemma* or the sheath of Schwann. They are most numerous in the sympathetic system.

(2) The *medullated, white* fibers—axis cylinders or neuraxons—are surrounded by *myelin* or the white substance of Schwann (also called medullary sheath), which in turn is covered by the sheath of Schwann or neurilemma. They are found principally in the cerebrospinal nerves. Here and there under the sheath of Schwann are found the *nodes of Ranvier*, annular constrictions about which the myelin is wanting.

Define (a) afferent, (b) efferent, (c) trophic, (d) inhibitory, and (e) motor and vasomotor nerve fibers.

(a) One carrying impulses to the central nervous system from the various parts of the body. The optic nerve carries impulses received on the retina to the brain.

(b) One carrying impulses from the nerve cell to the various parts of the body. The facial nerve carries motor impulses from the corresponding center in the brain to the muscles of expression.

(c) Nerves influencing the nutrition, metabolism, and growth of the tissues to which they are distributed. Lesions involving destruction of the trophic nerves and centers cause atrophy of the corresponding tissues (muscles, cartilage in joints, and bones).

(d) Nerves carrying impulses which tend to suppress or diminish a movement or secretion already present.

(e) Nerves carrying motor impulses from the brain or cord to the various muscles of the body.

(f) Nerves carrying impulses which control the muscular tone of the walls of blood-vessels.

Describe the action of the vasomotor nerves.

The vasomotor nerves contain *pressor* (constrictor) and *depressor* (dilator) fibers. Irritation of the pressor fibers causes stimulation of the vasomotor center in the medulla and increased tone in the blood-vessels (vasomotor

tone). Irritation of the depressor fibers causes reflex diminution of the irritability of the center. The vasomotor nerves serve to regulate the blood-pressure and the amount of blood going to a part; they also contribute to the regulation of the body temperature by increasing and diminishing evaporation from the surface.

Define reflex action and give examples.

Action resulting from an afferent impulse, followed by an efferent impulse, without the intervention of the higher cerebral centers. Reflex action is independent of the will. *Examples:* Tapping the tendon of the quadriceps extensor is followed by a reflex contraction of the muscle (knee-jerk). The pupils contract under the influence of light and accommodation.

Explain the physiologic circuit essential to a reflex action.

A centripetal fiber, a ganglionic nerve center in the gray matter, a centrifugal fiber (cord or medulla), and muscle or other peripheral organ supplied by the efferent nerve. This is called the *reflex arc*.

Mention (a) the superficial reflexes, and (b) the deep reflexes.

(a) Abdominal, cremasteric, plantar, palpebral, palatal, and corneal conjunctival.
(b) Knee-jerk or patellar reflex, ankle-clonus, bicipital reflex, chin reflex, and pupillary reflex.

What test should be applied to ascertain the integrity of (a) the superficial reflexes, and (b) the deep reflexes?

(a) The plantar reflex—movement of the toes on stroking the sole of the foot; the cremasteric—retraction of the testicle on stroking the inside of the thigh; the conjunctival—closure of the eyelid on tapping the conjunctiva, and many others.
(b) The integrity of the deep reflexes is best ascertained by testing the knee-jerk (see above) or the bicipital reflex—contraction of the biceps on tapping the tendon at the elbow.

What is the physiologic significance of the normal patellar reflex and through what nerves is it accomplished?

Health: it is present in all but about 5 per cent. of normal individuals. *Afferent path:* posterior root of fourth lumbar nerve; efferent path: fourth and fifth lumbar nerves.

What is ankle-clonus?

A vibratory movement of the foot obtained by supporting the tendo Achillis with one hand while the foot is strongly flexed with the other. It is rarely obtained in health, but is often marked in hysteria and in lateral sclerosis.

Give illustrations of morbid reflex action.

The vomiting of pregnancy is caused reflexly by irritation of the mucous membrane of the uterus. Faulty digestion may cause reflex palpitation of the heart.

Describe the Babinski reflex and explain its significance.

Extension of the toes, instead of flexion, following irritation of the sole of the foot. It occurs in lesions of the pyramidal tract and indicates some organic lesion of the motor tract. The phenomenon is present in normal children up to the age of two.

Mention (a) special sensations, and (b) common sensations.

(a) Sensations of pressure, temperature, muscular sense, and locality.
(b) Pain, itching, tickling, and the feelings due to electric stimulation.

How is the sensation of pain produced?

Stimulation of the special endings of the pain nerves in the skin, or stimulation of the trunk of the nerve causes an impression to be sent to the special area of the brain presiding over pain sensations. Stimulation of this center results in the subjective sense of pain.

Describe the origin of a tear as the result of pain.

The pain causes reflex stimulation of the lacrimal gland, followed by increased secretion. More secretion is produced than can be carried off by the lacrimal canal and the excess overflows from the conjunctival sac as tears.

Describe the arrangement of the sympathetic nervous system.

It consists of (a) a *pair of gangliated cords*, which are placed on the front and sides of the vertebral column, and (b) three great prevertebral plexuses: the *cardiac* plexus, contained in the thoracic cavity; and the *solar* and *hypogastric* plexuses in the abdominal cavity. The anterior branch of each spinal nerve gives off a visceral branch—*communicating branch of the sympathetic*—and these visceral branches collect to form the *sympathetic chain.* In the thoracic portion there is a ganglion at the point where each visceral branch enters the sympathetic; in the cervical portion the eighth and the seventh, and also the sixth and the fifth nerves are represented by single ganglia, and the four upper cervical nerves by the *superior cervical ganglion.* Each ganglion is connected to the corresponding spinal nerve by two *rami communicantes*, a white and a gray. The white consists of *medullated* fibers, which enter the ganglion and pass through it toward the viscera. The gray ramus communicans is formed of *non-medullated* fibers and passes back from the ganglion to join the spinal nerve, giving off *afferent* fibers, which enter the spinal cord, and *efferent* fibers, which join the spinal nerve, forming vasomotor and pilomotor nerves and nerves to the sweat-glands in the skin.

Give the varied functions of the sympathetic nerve.

Vasomotor, secretomotor, pilomotor, innervation of the sweat-glands, acceleration of the heart, inhibition, and motor control of the intestines. Sympathetic fibers also control the movements of the iris—dilatation of the pupil.

What are the functions of the main sympathetic ganglia?

Dilatation of the pupil (cervical ganglion), regulation of the heart action (automatic ganglia of the heart), control of the movements of the intestines, and digestive processes (abdominal ganglia).

State the effect of (a) stimulation of the cervical sympathetic nerve. (b) Section of the cervical sympathetic nerve.

(a) Dilatation of the pupil (mydriasis).
(b) Contraction of the pupil (miosis).

Which of the cranial nerves are nerves of special sense? Give the origin and function of each nerve mentioned.

Olfactory: Origin by three roots, the external from the amygdaloid nucleus and adjacent portion of the cortex; the middle from the anterior commissure; and the internal from the gyrus fornicatus. *Function*—smell.

Optic: Origin by two roots, external and internal geniculate bodies, pulvinar of the optic thalamus, and superior corpora quadrigemina. *Function*—sight.

Auditory: Superficial origin, lower border of pons; deep origin by two roots, a lateral and a mesial. The lateral root is the true nerve of hearing and arises chiefly from the accessory nucleus. *Function*—hearing.

(a) What three cranial nerves are for special sense? (b) What six are exclusively motor? (c) What three are compound?

(a) Olfactory, optic, and auditory.
(b) Oculomotor, trochlear, abducens, pneumogastric, spinal accessory, and hypoglossus.
(c) Trigeminal, facial, and glossopharyngeal.

What is the function of the first cranial nerve?

It is the nerve of smell.

State the function of the nervus opticus, and explain by description or diagram the distribution of the fibers composing the chiasm and the effect thereof upon vision.

The nervus opticus is the nerve of the special sense, sight. At the chiasm the inner half of each optic nerve crosses to the opposite side; therefore, in loss of function of one optic nerve, from injury or pressure back of the chiasma, there is blindness of the temporal side of retina of the same eye and of the nasal side of the opposite eye.

Give the foramen of exit, the distribution, and the function of the oculomotor nerve.

The oculomotor nerve leaves the skull through the sphenoidal fissure. It supplies motor filaments to the superior, internal, and inferior recti, inferior oblique, levator palpebræ superioris, ciliary muscle, and constricting fibers of the iris.

State the function of the third cranial nerve. What is the effect of division of the third cranial nerve?

See preceding question. Section of this nerve causes loss of accommodation, ptosis, external or divergent squint, and diplopia.

Give the foramen of exit, the distribution, and function of the pathetic (fourth cranial) nerve.

The pathetic or trochlear nerve passes out through the sphenoidal fissure and is the motor nerve of the superior oblique.

What is the function of the trochlear nerve?

The trochlear nerve is the motor nerve of the superior oblique.

State the functions of the fifth cranial nerve.

The fifth nerve is the *sensory* nerve of the face, mouth, and nasal cavities, and the *motor* nerve of the muscles of mastication.

What is the function of the sixth (abducens) nerve?

The abducens is the motor nerve of the external rectus.

Give the physiologic properties of the facial nerve.

The facial nerve is the motor nerve for the muscles of expression of the face. Through the fibers of the *chorda tympani* and the *lingual nerve* it also subserves the sense of taste in the tip and margin of the tongue. The gustatory fibers of the chorda tympani originate in the glossopharyngeal nerve and enter the facial through the intermediary portion of Wrisberg.

What would be the effect of paralysis of the seventh cranial nerve (portio dura) on the right side?

Paralysis of the right half of the face.

Name the functions of the chorda tympani, sufficiently detailing each to clearly define its character.

The chorda tympani contains *sensory* (also tactile and thermic) and *gustatory* fibers for the anterior portion of the tongue; *secretory* fibers for the sublingual and submaxillary glands; and *vasodilator* fibers for those glands and for the anterior two-thirds of the tongue.

What is the function of the glossopharyngeal nerve?

The glossopharyngeal is the *nerve of taste* for the posterior third of the tongue and the lateral portion of the palate. It supplies motor fibers to the stylopharyngeus muscle; secretory fibers to the parotid gland. It is the *sensory* nerve for the posterior third of the tongue, the tonsils, the anterior palatine arches, the soft palate, and a portion of the pharynx.

What are the functions of the pneumogastric nerve?

Among its many functions the pneumogastric is motor and sensory to the larynx; motor to the pharynx and esophagus; motor, sensory, and secretory to the stomach; *inhibitory to the heart;* motor and sensory to the lungs; and sends some filaments through the sympathetic system to the pancreas, liver, and intestines.

What is the function of the superior laryngeal nerve?

The superior laryngeal is the motor nerve of the cricothyroid muscles and the sensory nerve of the larynx.

Give (a) number of spinal nerves, and (b) function of anterior and posterior roots.

(a) Thirty-one.
(b) Motor and sensory, respectively (Bell's law).

State the function of the anterior spinal nerve-roots. How is the function proved?

They supply *motor* fibers to all the striated voluntary muscles of the trunk and extremities and to certain organs, the bladder, uterus, and skin; *vasomotor* fibers to the vessels; *sweat fibers* to the sweat-glands; and *trophic* fibers. Section of the anterior roots causes motor paralysis of the parts that they supply. Irritation of the peripheral ends causes contraction of the muscles they supply. Irritation of the central ends has no effect; no sensation is felt.

Describe the functions of spinal nerves.

The spinal nerves carry the afferent and efferent impulses of the body and of the back of the head to and from the central nervous system. Among the efferent impulses are those of pain, temperature, tactile, pressure, and muscular sense. Among the efferent are the motor, trophic, secretory, and vasomotor.

What would be the effect of a transverse section of (a) the anterior root of a spinal nerve, and (b) the posterior root of a spinal nerve?

Transverse section of the *anterior* root would cause motor paralysis of the muscles supplied, and finally atrophy of the muscles. Transverse section of the *posterior* root would cause loss of sensation of the part supplied.

What are the functions of the spinal cord?

The spinal cord is the great motor and sensory pathway to and from the periphery. In the anterior horns are found the cells concerned in the muscular reflexes and also the trophic centers for the muscles. Beside the muscular reflex centers, the cord contains the following centers: anospinal, vesicospinal, genitospinal, uterospinal, sweat, minor vasomotor, and possibly ciliospinal.

Explain the functions of the principal columns of the spinal cord.

The *anterior* and *lateral columns*—the pyramidal tracts—convey motor impulses to the voluntary muscles of the same side. Sensation, pain impressions, sensation of heat and cold, and muscular and pressure sensations are conveyed through the *posterior columns*.

Describe the effect of a transverse section of the spinal cord in the mid-dorsal region.

A transverse dorsal section would cause paralysis of motion and of sensation of the parts below the section, paralysis of bladder and rectum, and exaggerated reflexes of the legs.

What are the respective functions of the anterior and of the posterior cornua of the spinal cord?

The anterior cornua are motor in function and contain the trophic centers for the muscles. The posterior cornua are mostly relay stations on the sensory pathway.

Where is the respiratory center? Where is the center of defecation?

The respiratory center is situated in the *floor of the fourth ventricle*, between the nuclei of the vagus and spinal accessory nerves. The center for defecation—Budge's anospinal center—is situated in the spinal cord, at the level of the *fifth* dorsal vertebra.

Name the principal centers of organic function in the medulla oblongata.

Respiratory, cardio-inhibitory, cardio-accelerator, vasomotor; centers for salivation, mastication, deglutition, vomiting; and diabetic center.

Describe the offices and the characteristics of the gray matter of the brain.

The gray matter of the cerebral cortex is arranged in six alternate gray and white layers, the most important of which is the deep gray layer of large pyramidal cells. The gray matter of the cerebrum is the center of sensation, volition, and ideation; that is, it receives the sensation, sends out all voluntary impulses, and is the part of the nervous system in which thought goes on.

What differences of function exist between the white and the gray matter of the encephalon?

The *gray matter* is composed of cells which are the terminals that receive sensation, classify the knowledge thus received, and send out impulses. The *white matter* is made up of fibers that transmit the impulses connecting the cells with each other and with the periphery.

What portion of the cerebrum comprises the motor area?

The motor area is found along the fissure of Rolando, in the ascending frontal, ascending parietal, and paracentral convolutions, and contiguous parts of the superior frontal.

From what portions of the cortex cerebri do the arm, face, and leg receive their motor impulses?

The fissure of Rolando in the ascending frontal, ascending parietal, and paracentral convolutions. The leg center is the uppermost, the arm center next, and the face center the lowermost.

Locate in the brain the seat of the special sense of sight, hearing, and smell.

Sight has its seat in the gyrus angularis, *cuneus*, and in the occipital lobes; hearing in the *superior temporal convolution;* and smell in the *uncus*.

Describe the paralysis resulting from a destructive lesion which involves the posterior limb of the internal capsule.

Paralysis of the opposite side of the body with redness, elevation of temperature, swelling, sweating, and rapid trophic changes (decubitus) in the affected extremities. Contractures subsequently occur in the paralyzed muscles, and abnormalities of the skin and cutaneous structures appear.

What are the effects of the removal of the cerebrum in the lower animals?

A decerebrated animal loses all power of voluntary movement, remaining quiescent until some external stimulus brings out a reflex movement. Thus, the animal will not take food that is placed before it; but if the food is placed in its mouth, it will swallow it. If turned on its back it will right itself. It shows no fear.

What is the function of the cerebellum?

The function of the cerebellum is the co-ordination of muscular movements. It also provides voluntary movements with sufficient strength and increases the tone of the muscles during rest.

What are the functions of the brain membranes?

The *dura mater* is tough and protects the brain. It also supplies the place of an internal periosteum to the bones of the head. The *arachnoid* is a thin, spider-like membrane covered with endothelial cells that secrete cerebrospinal fluid. The *pia mater* is a vascular membrane dipping down into the sulci and carrying blood to the cortex.

Explain the function of the ciliary muscle.

In contracting, the ciliary muscle draws the margin of the choroid forward, relaxing the zonule of Zinn. This relieves the traction on the lens, which, by virtue of its elasticity, assumes a more convex shape and the eye is focused for near objects.

ORGANS OF SPECIAL SENSE

Name the organs of the special senses.

The eye, the ear, the upper portion of the nasal cavities, the taste-bulbs on the tongue, and the tactile end-organs.

What are the movements of the eyeball? Mention the muscles concerned in each of the movements.

Protrusion: muscular fibers in the capsule of Tenon.

Retraction: effected by tightly closing the lids or by paralysis of the muscular fibers of the capsule of Tenon.

Upward rotation: superior rectus and inferior oblique.

Downward rotation: inferior rectus and superior oblique.

Inward rotation: internal rectus.

Outward rotation: external rectus.

Rotary rotation: both oblique muscles.

Describe the different coats of the eye and give the functions of each.

1. *External* or *fibrous coat*, formed by the sclerotic and cornea, consisting of fine connective-tissue fibers. The *cornea* is transparent, the sclera white and opaque. The *sclera* is almost avascular, except for a large venous sinus at the corneal junction—the canal of Schlemm. The cornea contains no blood-vessels except at its periphery; by virtue of its transparency, it admits the rays of light, and by its convexity takes part in the refractive mechanism of the eye. The sclera is the protecting coat of the eyeball.

2. *Middle* or *vascular coat* containing the uveal tract, iris, ciliary body, and choroid. The *choroid* forms the posterior part of the tract and contains pigment and blood-vessels. In front of the choroid is the *ciliary body*, which also contains blood-vessels, and the *ciliary muscle*, the muscle of accommodation (see page 183, third question). The anterior part of the uveal tract is formed by the *iris*, which acts like a diaphragm by cutting off the marginal rays and regulating the amount of light that enters the eye.

3. *Internal* or *nervous coat*—the *retina*. This contains the rods and cones, or neuro-epithelium, which are sensitive to light.

Name the refracting media of the eye and the effect that each has on the rays of light.

The cornea, aqueous humor, crystalline lens, and vitreous body. They all converge the rays of light in the following order of potency: crystalline lens, vitreous body, aqueous humor, and cornea.

Describe the crystalline lens and state its relations and functions.

The *lens* is a biconvex, transparent body enclosed in a hyaline, elastic capsule. The posterior surface is more convex than the anterior. The lens is suspended within the globe by a suspensory ligament, the *zonule of Zinn*, attached to the capsule and swung from the ciliary processes. The outer portion or *cortex* is softer than the central portion or *nucleus*, which is quite dense. The lens comes in relation in front with the aqueous humor and pupillary border of the iris; behind with the anterior surface of the vitreous, which receives it in a cup-like depression; peripherally, by the suspensory ligament, with the ciliary region. The crystalline lens is the organ of accommodation and refracts the different rays of light by altering its convexity.

What are the functions of the iris?

The iris is a circular muscular membrane or curtain with a round central opening. Its functions are: (1) to cut off the marginal rays like the diaphragm in a microscope and thus render vision more distinct; (2) to regulate the amount of light that enters the eye by contracting under strong illumination and relaxing (dilating the pupil) when the light is feeble; and (3) to assist the action of the muscle of accommodation.

Account for the contraction and dilatation of the pupil.

It is a reflex phenomenon regulating the amount of light that enters the eye and sharpening the image for near vision. The iris contains two sets of fibers; circular or contracting (*sphincter iridis*), and radiating or dilating (elastic) fibers.

Of the functions of vision, what is understood by accommodation?

The act of increasing the curvature of the anterior surface of the crystalline lens to focus near objects on the retina.

How is accommodation in the eye accomplished?

At rest, the lens is held flat against the vitreous body by the traction of the stretched zonule of Zinn, which is attached to its margin. When the ciliary muscle contracts to focus for near objects, it draws the margin of the choroid forward, and the zonule, which is in intimate relation with it, is relaxed and allows the lens, by virtue of its elasticity, to assume a more convex form (it becomes thicker). The posterior surface does not take part in the increase of curvature.

State the function of the retina.

The retina is the receptive nervous organ of sight (see page 182, first question).

Define myopia, hypermetropia, and astigmatism. State the cause of each condition.

Myopia is a visual defect in which parallel rays of light are focused *in front* of the retina. The usual cause is an increase in the length of the anteroposterior diameter of the eye.

In *hypermetropia* parallel rays of light are focused *behind* the retina. It is generally caused by a shortening of the anteroposterior diameter of the eye.

Astigmatism is an error of refraction in which rays of light in the various meridians cannot be united at a single point. The rays that pass through the vertical meridian come together first, while the rays passing through the horizontal meridian are brought together in a more posterior plane (*regular astigmatism*). The error is generally due to irregularities in the curvature of the cornea, sometimes of the lens.

What is the condition of the eye in myopia? How may it be corrected?

In myopia the eyeball is longer than normal and the rays of light are brought to a focus in front of the iris. The error can be corrected with a *concave* lens.

Describe the rods and cones of the retina.

The *rods* and *cones*, visual cells or *neuro-epithelium*, form the external coat of the retina and are separated from the choroid by pigment. They are absent at the entrance of the optic nerve. The rods are more numerous than the cones (5 to 1), but are absent in the macula lutea, where cones alone are present. The outer portions of the rods contain a red pigment,

the *visual purple*. The cones are shorter than the rods and contain no purple. The rods and cones are the only parts of the retina that are sensitive to light and constitute the active, receptive organ of sight.

How are the sensations of color produced?

(1) According to one theory the nervous elements of the retina are uniform in type, but are affected in different ways by variously colored lights, depending on different wave-lengths in the vibrations of ether, rapidity of vibration, and refractive exponent.

(2) The Young-Helmholtz theory assumes the existence of three different sets of retinal fibers, corresponding to the primary colors. Stimulation of the first set produces the sensation of red; of the second, green; and of the third, violet. Stimulation of any two sets of fibers produces the impression of a mixed color; the stimulation of all, the sensation of white. The cones alone are supposed to be concerned in light perception, the rods merely with the power of distinguishing between quantitative sensations of light.

(3) According to the Ewald-Hering theory there is one set of fibers, while there are three chemical substances found in visual purple. The anabolism of these causes white, red, and yellow; catabolism, black, green, and blue. Various combinations cause various shades.

Describe color blindness and name the colors which the subject commonly fails to distinguish.

The inability to recognize certain colors, usually red and green.

Locate the visual center.

The exact location is in dispute, but the weight of evidence is in favor of the *cuneus*, or upper portion of the occipital lobe. Accessory centers are probably present in the external geniculate body, the pulvinar of the optic thalamus, and the superior corpus quadrigeminum.

Name the nerve supply to each muscle of the eye.

Superior rectus: third cranial or oculomotor.
Inferior rectus: third cranial or oculomotor.
Superior oblique: fourth cranial or trochlear.
Inferior oblique: third cranial or oculomotor.
External rectus: sixth cranial or abducens.
Internal rectus: third cranial or oculomotor.
Levator palpebræ superioris: third oculomotor and sympathetic.
Ciliary muscle: third oculomotor.

Give the mechanism of the organ of hearing.

The sound waves are collected by the auricle or external ear and conveyed through the external auditory meatus to the membrana tympani or *drumhead*, which divides the meatus from the middle ear. A chain of minute bones, the auditory *ossicles—malleus*, *incus*, and *stapes*—occupy the middle ear and connect the drumhead with the internal ear. The sound waves impinging upon the drumhead set up vibrations in the membrane, which are transmitted by the chain of ossicles to the endolymph of

the labyrinth of the internal ear. These vibrations in the endolymph are transmitted to the *organs of Corti*, which are contained in the scala media of the internal ear and form the special receptive apparatus of hearing. The auditory impressions are then conveyed to the auditory center in the cerebrum by the cochlear branch of the auditory nerve.

Which of the auditory ossicles is in contact with the membrana tympani?

The malleus, by means of its manubrium or handle.

How is the sensation of sound conveyed to the brain?

Through the cochlear branch of the auditory nerve to the medulla, thence to the superior olive and, through the lateral fillet and posterior quadrigeminal bodies, to the auditory center in the superior temporal convolution.

How and why is hearing affected by rupture of the membrana tympani?

Acuity of hearing is impaired by rupture of the membrane, which takes an important part in the transmission of the sound waves to the ossicles and internal ear.

What is the function of (a) the external ear? (b) Of the auditory canal?

(a) The function of the auricle is insignificant; it probably assists in collecting the sound waves, but its loss is followed by only slight diminution in the acuteness of hearing.

(b) The auditory canal conducts the sound waves to the tympanic membrane.

Why is the tympanic membrane sloped from without inward?

The oblique position allows the membrane to present a greater surface to the impinging sound waves than would be the case if it were placed vertically.

What is the function of the tensor tympani muscle?

To draw the handle of the malleus, and with it the membrana tympani, inward.

Describe the olfactory apparatus. What part of the olfactory apparatus is the seat of smell?

The upper portion of the nasal cavities contains the nerve endings of the olfactory nerve. These are specialized cells provided with small, hair-like processes. From these cells the olfactory nerve passes through the olfactory bulbs to the cerebrum, ending in the uncus of the same side.

What conditions are necessary for properly exercising the sense of smell?

The odoriferous substances must be volatile, the air in the nasal cavities must be in motion, and the olfactory apparatus must be in a normal condition.

What nerve supplies the posterior third of the tongue with taste and sensation?

The glossopharyngeal is the gustatory nerve for the posterior third of of the tongue; sensory and tactile fibers are supplied by the lingual nerve, a branch of the trifacial.

Name and locate the papillæ of the tongue.

Circumvallate papillæ near the base of the tongue, in two rows, forming a V, seven to twelve in number. *Fungiform* papillæ situated in front of the circumvallate and irregularly distributed on the dorsum, sides, and tip of the tongue. *Filiform* papillæ, thickly scattered over the entire organ in front of the circumvallate.

What nerves are concerned in taste?

The *lingual nerve*, a branch of the fifth cranial, supplies gustatory fibers to the tip and margins of the tongue. The gustatory fibers are obtained from the *chorda tympani*, which are given off to the tongue as the nerve runs in the lingual. They originate in the *glossopharyngeal* nerve. The glossopharyngeal supplies gustatory fibers to the posterior third of the tongue, the lateral portion of the soft palate, and the glossopalatal arch.

Describe the nerve arrangements on which the sense of touch depends.

The tactile fibers contained in the sensory nerve trunks and their terminations; the tactile corpuscles of Meissner in the skin (corium); the corpuscles of Vater and Paccini in the subcutaneous tissue; Krause's longitudinal end bulbs in the conjunctiva, the floor of the mouth, lips, nasal mucous membrane, etc.

DEVELOPMENT

Explain how the seminal fluid is conveyed to the vesiculæ seminales.

The seminal fluid is secreted by the *seminiferous tubules*, or true glandular tissue of the testicle. A number of seminiferous tubules unite to form a single straight excretory tube, or *tubulus rectus*. After anastomosing with one another, with the production of a network in the mediastinum of the testis, which is known as the *rete testis*, these channels unite to form about twelve tubes, the *vasa efferentia*, which form the *globus major*. The union of the vasa efferentia gives rise to the tube of the epididymis, the prolongation of which is the *vas deferens*. The latter passes up through the inguinal canal as the principal constituent of the spermatic cord, and comes in relation with the *vesiculæ seminales* on the posterior surface of the bladder.

Give the present physiologic conclusions in respect to the presence of the corpus luteum as a sign of pregnancy.

It is a sign of some value, especially as indicating the ovary from which the impregnated ovule came. Inasmuch, however, as corpora lutea, due probably to prolonged congestion, have been found in virginal ovaries, their presence is not a positive sign of pregnancy.

Give the process of regeneration of uterine membrane following pregnancy.

After the expulsion of the fetus at term the upper cellular layer of the uterine decidua undergoes fatty degeneration and is discharged with the lochia, laying bare the glandular portion of the uterine mucous membrane. Active proliferation of the glandular epithelium now takes place; the interglobular connective tissue, which shares in the process of regeneration, becomes more robust and rises above the glands until the characteristic utricular glands are restored. The process occupies about six weeks.

Describe the process of segmentation of the ovum.

The ovum, immediately after impregnation, undergoes indirect division or *karyokinesis*, resulting in the formation of two cells, which again subdivide to form four cells, and so on. Owing to more rapid development of some of the cells, the primary single layer subdivides into two layers, an inner or *entoderm*, and an outer, called *ectoderm*, and surrounding the former. Later a third layer, the *mesoderm*, is formed between the ectoderm and entoderm.

Give the derivatives of the three primary blastodermic layers.

1. *Ectoderm:* The skin and epithelial glands and appendages; the epithelium lining the nasal and oral cavities, including the glands; the enamel of the teeth; the epithelium of the conjunctiva and cornea; the tissues of the nervous system, the retina, and crystalline lens.

2. *Mesoderm:* The connective tissues, including areolar tissue, tendon, cartilage, bone, and dentine; the muscular tissues; the vascular and lymphatic systems; the kidney and ureter; and the sexual glands.

3. *Entoderm:* The epithelium and glandular structures of the digestive tract, except those of the mouth (ectodermic); the epithelium of the respiratory tract; and the bladder and urethra.

Describe the fetal circulation.

The peculiarities of the fetal circulation are due to several factors: 1. The presence of a placenta, which supplies the functions of the lungs. 2. The *ductus venosus*, a communication between the umbilical vein and the inferior cava. 3. The patency of the foramen ovale, connecting the two auricles. 4. The uninflated condition and small size of the fetal lungs. 5. The *ductus arteriosus*, extending from the beginning of the pulmonary artery to the descending aorta.

The placental blood (arterial) is conveyed by the single umbilical vein to the under surface of the liver, where the current divides, one part entering the portal vein, the other passing directly into the inferior cava without traversing the liver. On entering the right auricle the column of blood from the inferior cava (chiefly arterial) is directed by a membranous fold, the *Eustachian valve*, through the *foramen ovale*, into the left auricle, while the blood from the superior cava (venous), crossing this stream at a right angle, passes through the right auriculoventricular orifice and fills the right ventricle. The two currents practically do not mix. From the left auricle, which also receives the small quantity of (venous) blood returned from the uninflated lungs by the pulmonary veins, the current passes

through the left auriculoventricular orifice into the left ventricle, by the contractions of which it is propelled into the aorta and its branches, and distributed to all parts of the body.

The blood from the superior cava (venous), which has entered the right ventricle, is forced into the pulmonary artery, and a small portion enters the lungs, as in the adult; the greater portion, however, is conveyed directly to the aorta by the *ductus arteriosus*, which extends from the beginning of the left pulmonary artery to the aorta. In the aorta it mingles with the blood coming from the left ventricle; part of this supplies the lower extremities of the fetus, while the greater portion is carried back to the placenta for oxygenation by the *hypogastric arteries.*

What are the Wolffian bodies? When do they appear and into what organs do they ultimately develop?

The Wolffian bodies are transient excretory organs in the fetus, the forerunners of the kidneys. They appear about the eighteenth day, and by the fourth month have become atrophied. Portions of the Wolffian bodies in the female develop into the parovarium, and in the male into the vasa efferentia (coni vasculosi), and parts of the epididymis and vas deferens.

Give the process of development of the parietal bone.

The parietal bone develops by "intramembranous bone formation" from an earthy spot in the outer layer of the dura mater. The center of ossification corresponds to the parietal eminence. The cells of the osteogenetic layer of the membrane, as in the formation of periosteal bone, are arranged along the surfaces of the periosteal fibers and become surrounded by the bone matrix, which is derived from the cells. The matrix gradually thickens and lacunæ are formed, within which lie the osteoblasts, which have now become the star-shaped bone corpuscles. Hardening of the matrix later takes place through the deposition of lime salts, principally phosphate and carbonate. The process is practically the same as that of periosteal bone formation.

State the approximate time of eruption of the temporary teeth.

The lower central incisors are the first to appear, about the seventh month, and are shortly followed by the upper central and lateral incisors. The latter erupt about the ninth month. The first molars appear at about the age of one year. The canines, appearing between the eighteenth and twentieth months, and the second, or "second-year" molars, between the twenty-fourth and thirtieth months, complete the temporary set of teeth, which has no bicuspids.

ANATOMY

Give a brief yet comprehensive description of the heart.

The heart is a muscular structure surrounded by the pericardium. It consists of four cavities—two auricles and two ventricles. The auricles receive the blood from the large veins and transmit it to the ventricles. Their walls are thin in comparison with those of the ventricles. The *right auricle* receives the blood from the superior and inferior venæ cavæ; its inner surface is smooth, except in the *auricular appendix*, a small cavity arising from the upper inner surface of the auricle, which contains numerous rugæ called musculi pectinati. On the inner surface of the right auricle one finds the annulus ovalis, which in fetal life is a foramen communicating with the left auricle. The *Eustachian valve* is a fold of the lining situated below the opening of the inferior vena cava. Below the Eustachian valve the opening of the coronary sinus is situated. The right auricle communicates with the right ventricle by means of the tricuspid orifice, which is closed by the *tricuspid valve*. The *left auricle* resembles the right in that it is smooth and has an auricular appendix. The four pulmonary veins empty into it, and it communicates with the left ventricle by means of the mitral orifice, which is closed by the *mitral valve*.

The *right ventricle* is the largest of the four cavities; its walls are irregular and marked by rugæ, which are called *columnæ carneæ*. The tricuspid valve has three leaflets, each leaflet being connected to the ventricular wall by a papillary muscle; the attachment between the valve and the muscle is called a *chorda tendinea*. The ventricle expels its contents into the pulmonary artery, which is guarded by three semilunar folds or valves.

The *left ventricle* receives the blood through the mitral valve. The cavity resembles the right, except that it is smaller, and the papillary muscles are larger and fewer in number, the mitral valve having only two leaflets. The columnæ carneæ are also larger and fewer in number. The walls of the left ventricle are thicker than those of the right. The blood is pumped into the aorta through the aortic orifice, which is guarded by three semilunar valves.

The *coronary arteries* arise from the beginning of the aorta and are two in number, one for the right, and one for the left side of the heart. The *veins* which drain the heart muscle empty into the coronary sinus of the right auricle. The *nerve supply* is derived from the pneumogastrics and from the cardiac plexus of the sympathetic.

Locate and describe the pericardium.

A pyramidal, fibroserous sac surrounding the heart and great vessels, the base attached to the central tendon of the diaphragm, the apex corresponding to the great vessels at the base of the heart and connected with

the deep cervical fascia by fibrous prolongations. It is placed behind the sternum and the cartilages of the third, fourth, fifth, sixth, and seventh ribs of the left side, in the interval between the pleuræ. Outer layer fibrous; inner serofibrous. *Arterial supply:* from internal mammary and descending aorta. *Nerves:* phrenic and sympathetic.

Describe the endocardium.

A thin membrane lining the internal surface of the heart; it assists in forming the valves by its reduplications, and is continuous with the intima of the vessels. It is smooth and transparent, and covered with a single layer of *endothelial cells.*

Beneath what point on the anterior chest surface are the cardiac valves?

Pulmonary: To the left of the upper part of the third left chondrosternal junction. *Aortic:* behind left half of sternum, opposite lower border of third costal cartilage. *Mitral:* behind left half of sternum, opposite fourth rib. *Tricuspid:* opposite middle of sternum, at the level of the fourth and fifth cartilages.

What are the special characteristics of the left ventricle of the heart?

It forms the apex of the heart and contains the aortic opening. Its walls are thicker than those of the right ventricle.

Its musculi papillares are fewer in number and larger. The auriculoventricular (mitral) valve is made up of two segments.

What arteries supply the heart with blood, and where do they originate?

The coronary arteries (two), springing from ascending aorta: the right from the anterior sinus of Valsalva; the left from the left posterior sinus of Valsalva.

Where is the foramen ovale of the heart and what purpose does it serve?

In the wall between the auricles. It permits the passage of blood in the fetus from the right to the left auricle, and carries the blood which enters the left auricle from the inferior vena cava to the right auricle, thereby saving the pulmonary circulation from engorgement.

Describe the changes that take place in the vascular system at birth.

The blood ceases to flow through the umbilical vein and ductus venosus into the inferior cava; the hypogastric arteries become obliterated; the foramen ovale closes and the blood no longer passes from the right to the left auricle. The ductus arteriosus, which connects the pulmonary artery with the arch of the aorta, becomes impervious, and the pulmonary circulation is established.

Describe the structure of the arteries and give their nerve and blood supply?

The arteries have three coats: an inner, endothelial layer, the *intima*, strengthened by yellow elastic tissue; an intermediate, circular layer of unstriped muscle, the *media;* and an outer layer, the *adventitia*, consisting of connective tissue with connective-tissue corpuscles. In addition, the arteries are enclosed in a connective-tissue sheath. The blood supply is effected by small arteries—the vasa vasorum—which are distributed to the outer and middle coats and arise from the same, or from an adjacent vessel. The blood is returned by small veins. The arteries are supplied with medullated and non-medullated *nerve fibers*, which form plexuses on the outer surfaces of the vessels.

What is the circle of Willis?

An arterial anastomosis at the base of the brain. It is formed *in front* by the anterior cerebral arteries, branches of the internal carotid, which are connected by the anterior communicating; *behind*, by the posterior cerebrals, branches of the basilar, which are connected on each side with the internal carotid by the posterior communicating.

What arteries unite to form the basilar artery?

The two vertebrals.

Give the origin, distribution, and branches of the middle meningeal artery.

It is a branch of the internal maxillary artery. After passing through the foramen spinosum it traverses the wall of the middle cranial fossa and divides into anterior and posterior meningeal branches.

Give the origin and course of the pulmonary artery.

It springs from the anterior angle of the base of the right ventricle. Thence it passes upward and backward toward the concavity of the aortic arch, curving around the front and left side of the ascending aorta to reach a plane posterior to the latter, where it divides into its right and left branches opposite the fifth dorsal vertebra.

What blood-vessels pass to and from the liver?

The hepatic artery and portal vein and, in the fetus, the umbilical artery carry blood to the liver; the organ is drained by the hepatic veins.

Describe the external carotid artery.

Arising opposite the upper border of the thyroid cartilage, it passes upward and forward, and then inclines backward to the space between the neck of the condyle of the inferior maxilla and the external auditory meatus, where it divides into the superficial temporal and the internal maxillary. Other branches are superior thyroid, lingual, facial, occipital, posterior auricular, and ascending pharyngeal.

Name the branches of the subclavian artery.

Vertebral, internal mammary, superior intercostal, thyroid axis (inferior thyroid, transverse cervical, and suprascapular).

Through what arteries is the collateral circulation carried on after ligation of the subclavian artery?

After ligation of the third part of the subclavian (site of election), the circulation is maintained chiefly by *three* sets of vessels; a *posterior* set, consisting of the suprascapular and posterior scapular branches of the subclavian, anastomosing with the subscapular branch of the axillary; an *internal* set, consisting of the internal mammary, anastomosing with the superior and long thoracic and subscapular branches of the axillary; a *middle* set, consisting of small branches of the subclavian anastomosing with branches of the axillary artery.

Give the origin, main branches, and relations of any one of the following arteries: external carotid, axillary, and femoral.

The *axillary artery* is the continuation of the subclavian and extends from the outer border of the first rib to the lower border of the teres major. It is divided into *three* portions by the pectoralis minor. Relations of first portion in *front*, pectoralis major, costocoracoid membrane; *outer side*, brachial plexus; *inner side*, axillary vein; *behind*, ribs and intercostal muscles. Second portion: *in front*, pectoralis minor; *outer side*, outer cord; *inner side*, inner cord; *posteriorly*, posterior cord and subscapularis muscle. Third portion: *in front*, pectoralis major; *outer side*, coracobrachialis muscle, median and musculocutaneous nerves; *inner side*, ulnar and internal cutaneous nerves, and axillary vein; *behind*, subscapularis tendons of latissimus dorsi and teres major muscle; musculospiral and circumflex nerves. *Branches:* superior, acromial, long and alar thoracic; subscapular; and anterior and posterior circumflex.

Give the origin, course, and branches of any one of the following arteries: brachial, temporal, and left common carotid.

The *brachial* commences at the lower margin of the tendon of the teres major and passes down the inner and anterior aspects of the arm, terminating about half an inch below the bend of the elbow, where it divides into the radial and ulnar arteries. Its *branches* are: the superior and inferior profunda, nutrient, anastomotica magna, and muscular.

What would be the collateral circulation if the brachial artery were ligated below its profunda branches?

The superior and inferior profunda would anastomose with the anastomotica magna, the radial and interosseous recurrent, and the anterior and posterior ulnar recurrent.

Describe the location of the intercostal arteries.

They are located in the subcostal grooves on the under surface of the ribs.

What arteries, muscles, and nerves would be severed in a cross-section at the middle of the humerus?

The brachial, superior and inferior profunda arteries; the biceps and triceps muscles, the insertion of the deltoid, coracobrachialis, and the origin of the brachialis anticus muscles; the musculocutaneous, internal cutaneous, median, ulnar, and musculospiral nerves.

Describe the ulnar artery as to (a) origin, (b) course, and (c) distribution.

(a) It is the larger terminal branch of the brachial and commences in the antecubital fossa, terminating in the palm. (b) From its origin it runs obliquely downward and inward, beneath the muscles arising from the internal condyle, to the junction of the upper and middle thirds of the forearm. From that point it descends to the wrist, passing to the radial side of the pisiform bone, and forms the superficial palmar arch. (c) The ulnar artery supplies the structures on the inner side of the elbow, the ulnar side of forearm and wrist, interosseous membrane and adjacent muscles, also flexor surface of the hand.

In an amputation of the forearm 3 in. above the wrist, what arteries will it be necessary to tie, and of what are they branches?

Radial and ulnar arteries, branches of the brachial; anterior and posterior interosseous arteries, branches of the ulnar.

Describe the position of the palmar arterial arches.

The superficial arch lies upon the flexor tendons and passes across the palm at the level of the inner border of the thumb when in extreme abduction. The deep arch lies upon the metacarpal bones and interossei muscles, ½ in. nearer the carpus than the superficial arch.

Name the branches of the abdominal aorta.

Two phrenics, celiac axis, superior and inferior mesenteric, suprarenals, renals, lumbar arteries (4), spermatic or ovarian, middle sacral, and right and left common iliacs.

Mention the principal branches of the celiac axis.

Gastric, hepatic, and splenic arteries.

Where does the abdominal aorta commence and where does it terminate?

It commences at aortic opening in diaphragm, on body of twelfth dorsal vertebra; terminates on body of fourth lumbar vertebra, just to left of median line.

Mention the branches of the internal iliac artery.

Anterior trunk: superior, middle, and inferior vesical, obturator, middle hemorrhoidal, uterine, vaginal, internal pudic, and sciatic. *Posterior trunk:* iliolumbar, gluteal, lateral, sacral, and, in fetal life, hypogastric.

What arteries supply the bladder in the male? Of what vessel are they branches?

Superior, middle, and inferior vesical, branches of internal iliac.

Describe the relation of the deep epigastric artery to the internal abdominal ring.

The artery descends to reach Poupart's ligament, then ascends obliquely along the inner margin of the internal abdominal ring and passes upward in the abdominal wall, between the transversalis fascia and the peritoneum.

Describe the common femoral artery and its branches.

The *common femoral* is the continuation of the external iliac. Commencing immediately behind Poupart's ligament, midway between the anterior superior spine and the symphysis, it passes down the thigh for 2 inches and divides into its terminal branches, the superficial and profunda femoris. The *superficial femoral* passes down the thigh through Scarpa's triangle and Hunter's canal and, after piercing the adductor magnus, becomes the *popliteal*. The *profunda femoris*, nearly equal in size to the superficial, passes downward beneath the adductor longus muscle, along the inner side of the femur. It gives off three perforating arteries and the external and internal circumflex, and terminates as the fourth perforating.

The *branches* of the common femoral are: the superficial epigastric, superficial circumflex iliac, and superficial and deep external pudic. The branches of the superficial are: the muscular and the anastomotica magna.

Describe the popliteal artery and give its branches.

The *popliteal artery* is a continuation of the superficial femoral. It begins at the opening in the adductor magnus and divides at the lower border of the popliteus muscle into the anterior and posterior tibial arteries; it lies upon the femur, posterior ligament of knee-joint, tibia, and fascia covering popliteus muscle; it enters the popliteal space at the upper inner margin and bisects it longitudinally. The *branches* are: the superior and inferior internal and external articular, azygos articular, sural, and anterior and posterior tibial.

If the femoral artery were obstructed at the apex of Scarpa's triangle, through what channels would the blood flow to reach the tibial arteries?

The new channels would be formed by the profunda and its branches. The external circumflex anastomoses with the anastomotica magna, the internal circumflex with the superior articular, and both anastomose with muscular branches. The comes nervi ischiadici branch of the sciatic anastomoses with branches from the popliteal and posterior tibial arteries.

Give the course of the posterior tibial artery.

It commences at the lower border of the popliteus muscle and terminates midway between the tip of the internal malleolus and the os calcis. The artery runs downward and inward between the superficial and deep flexor muscles of the calf.

In an amputation of the leg 5 in. below the knee, what arteries will it be necessary to tie and of what are they branches?

Anterior and posterior tibial, branches of popliteal; peroneal artery, branch of posterior tibial.

Describe the superior vena cava.

It returns the blood from the head, neck, upper extremities, thoracic wall, and a portion of the upper part of the posterior wall of the abdomen. It is formed behind the first right costal cartilage by the *union of the two innominate veins*, and descends, with a slight convexity to the right, to the level of the third right costal cartilage, where it opens into the upper and back part of the right auricle. The lower half is within the pericardium. Its *tributaries* are the vena azygos major, pericardial, and mediastinal veins.

Describe the inferior vena cava and name the veins that enter into its formation.

It returns the blood to the heart from practically all parts of the body below the diaphragm. It is formed by the *junction of the two common iliac veins*, on the right side of the intervertebral disk between the fourth and fifth lumbar vertebræ. Passing upward on the front of the spine, where it lies to the right of the aorta, it traverses the under surface of the liver in the fissure of the vena cava, perforates the central tendon of the diaphragm, and enters the pericardium, terminating in the lower back part of the right auricle.

Describe the right and left subclavian veins.

The *subclavian vein* extends from the lower border of the first rib to a point behind the sternoclavicular articulation, where it unites with the internal jugular to form the innominate. The vein lies in front of the artery, separated from its second portion by the anterior scalene muscle. Its *tributaries* are the external and anterior jugular.

On the *right* side the right lymphatic duct empties into the subclavian vein at its junction with the internal jugular; the *left* subclavian vein receives the thoracic duct at this point; otherwise the course and relations of the vein are the same on the two sides.

Describe the internal jugular vein.

The vein is formed in the jugular foramen by the junction of the lateral and inferior petrosal sinuses. It courses down the neck, beneath the anterior border of the sternocleidomastoid muscle, accompanied first by the internal, and then by the common carotid artery, and throughout its course by the pneumogastric nerve. The vein is contained *in the same sheath with the artery and nerve*, but separated from these structures by a distinct septum. At first the vein lies behind the internal carotid artery; but as it descends it gradually passes to the outer side of the vessel and later along the outer side of the common carotid, partially overlapping the artery in front, to its termination behind the sternoclavicular articulation, where it unites with the subclavian to form the innominate.

Give the course and relations of the external jugular vein.

The vein is formed on the surface of the sternomastoid muscle, below the angle of the jaw, by the *union of the posterior auricular with the temporomaxillary* vein. It descends to the anterior part of the subclavian triangle and there terminates in the subclavian vein, after piercing the deep fascia and crossing the third portion of the subclavian artery.

Describe the portal system.

It is made up of veins which drain the spleen, stomach, pancreas, and large and small intestines. The *splenic vein*, after receiving the inferior mesenteric, joins the superior mesenteric to form the *portal vein*, which receives the *gastric*. The portal vein passes behind the hepatic artery and bile duct in the lesser omentum and enters the transverse fissure of the liver where it divides into minute branches.

How are the saphenous veins formed? Where do the saphenous veins empty?

The *internal* is formed by the union of the inner extremity of the dorsal venous arch with the dorsal vein of the great toe; it empties into the femoral vein. The *external* is formed by the union of the outer extremity of the dorsal venous arch with the dorsal vein of the little toe and empties into the popliteal vein.

Give a general description of the cerebral veins.

They are remarkable for the thinness of their walls, due to lack of muscle tissue, and have no valves. The *superficial* cerebral veins are lodged in the sulci between convolutions; the veins receive blood from the substance of the brain and empty into the sinuses, pouring in their contents in a direction opposite to the current in the sinuses. The *deep* cerebral veins drain the ventricles into the straight sinus; the basilar vein drains the interpeduncular space and the basal ganglia.

What are the lymphatic glands?

They are globular, ovoid, flattened bodies, consisting of fibrous framework, lymph sinuses, and lymph follicles. They form part of the general lymphatic system.

Name the ductless glands.

Spleen, suprarenal bodies, thyroid, and thymus.

Describe the thoracic duct.

It begins on the body of the second lumbar vertebra in a dilated pouch called the *receptaculum chyli*, passes through the aortic opening in the diaphragm, and then through the posterior and superior mediastinum, to the base of the neck, where it arches to the left and terminates at the *junction of the left subclavian and internal jugular veins*. It drains the lymph from all parts of the body except the right upper extremity, right side of head and neck, right half of thorax (right lung and right side of heart), and upper surface of liver.

Give the situation of the lymphatic glands of the chest.

Intercostal, on each side of costovertebral articulations; *internal mammary*, at anterior extremity of each intercostal space; *diaphragmatic*, on upper surface of diaphragm; anterior, posterior, and superior *mediastinal*, in spaces of same name; *bronchial*, both within and outside the lung.

Mention and describe the salivary glands.

Parotid, submaxillary, and sublingual.

The *parotid gland* lies upon the side of the face, immediately below and in front of the ear, limited above by the zygoma. It empties its secretion into the mouth by way of *Stenson's duct*, which runs parallel with the zygoma and pierces the buccinator muscle and the mucous membrane of the cheek opposite the second molar tooth.

The *submaxillary gland* is below the jaw in the submaxillary triangle; it is irregular in form and weighs about 2 drams. *Wharton's duct* is about 2 inches long. It passes forward and inward and opens by the side of the frenum of the tongue.

The *sublingual gland* is situated beneath the mucous membrane of the floor of the mouth by the side of the frenum, in contact with the inner surface of the lower jaw. The *ducts of Rivinus*, eight to twenty in number, open on the floor of the mouth on each side of the frenum; one larger duct opens into Wharton's duct and is called the duct of Bartholin.

Structure: The salivary glands are compound racemose glands, consisting of numerous lobules, each one having a single duct, which terminates in an alveolus. The glands are of two kinds: one secretes mucin, the other serum-albumin. The sublingual gland is an example of the first variety, the parotid, of the second; while the submaxillary gland represents a combination of both varieties.

Give the course and relations of Stenson's duct.

Stenson's duct is formed in the parotid gland, crosses the masseter muscle a finger's-breadth below the zygoma, and perforates the buccinator muscle and the mucous membrane of the cheek opposite the second upper molar tooth.

Give the point of opening of the parotid duct, of the submaxillary duct, and of the sublingual duct.

The *parotid* duct opens in the cheek wall opposite the second upper molar tooth; the *submaxillary* duct opens in the mouth at the tip of the frenum linguæ; the *sublingual* ducts open on the floor of the mouth by the side of the frenum linguæ.

Describe the thyroid gland.

The *thyroid* is a ductless gland. When fully developed it consists of two lateral *lobes*, conical in form, situated on the sides of the upper portion of the trachea and alæ of the thyroid cartilages. The lobes are connected by a narrow transverse *isthmus*. At times a third lobe is found springing from the isthmus and extending upward. The thyroid is enveloped by a *capsule* of connective tissue, from the deep surface of which a number of processes penetrate into the organ, dividing it into lobes and lobules. Each *lobule* is made up of numerous closed vesicles filled with a viscid, semifluid, colloid material. Vessels and lymphatics are very numerous throughout the gland. *Arterial supply:* superior and inferior thyroid veins; superior, middle, and inferior thyroid. *Nerve supply:* from the pneumogastric, middle, and inferior cervical ganglion of the sympathetic system.

Locate and describe the lacrimal gland.

It is lodged in a depression near the outer angle of the orbit, on the inner surface of the external angular process of the frontal bone, and is about the size and shape of an almond. The vessels and nerves enter the gland at its posterior border. The anterior palpebral portion is separated from the body by a fibrous septum. It is a *compound racemose gland* consisting of small lobules connected by dense areolar tissue. The secretion is *serous* and is poured out on the conjunctiva by seven or eight ducts at the upper outer palpebral angle.

Describe the Meibomian glands.

They are *sebaceous* glands, each consisting of a straight follicle, with numerous small secondary follicles opening into it. They are about thirty in number on the upper, and twenty-five on the lower lid; occupying the inner surface of the eyelids, between the tarsal plate and the conjunctiva. The ducts open on the free margin of the lids. The secretion prevents adhesion of the lids.

Describe the mammary glands.

They are accessory glands of the generative system which *secrete milk* in the female, but exist only in a rudimentary state in the male. In the female the mammæ appear as two hemispheric glands on the front of the chest, between the third and the sixth ribs, and extending from the edge of the sternum to the anterior axillary fold. They consist of ten to sixteen *racemose* glands held together by fibrous and fatty tissue. Each lobule consists of a cluster of alveoli and is provided with a single, small duct, which expands into an ampulla before terminating at the apex of the *nipple*. There are fifteen or twenty of these *tubuli lactiferi*. The nipple is a conical eminence surmounting the glands and surrounded by a pigmented areola which contains small glands.

Locate and describe Peyer's glands.

They are entirely confined to the *small intestine*, being largest and most numerous in the ileum, and situated opposite the attachment of the mesentery. The glands consist of a large number of *lymphoid nodules* grouped closely together so as to form a slightly elevated area, usually oval in form. Length from ½ inch to 3 inches; width from ⅓ to ½ inch.

Describe Luschka's gland.

The *coccygeal gland* is a small body about the size of a pea, lying near the coccyx in a tendinous interval formed by the union of the levator ani muscles. It consists of small blood-vessels freely communicating and surrounded by several layers of polyhedral granular cells. The whole structure is invested in a capsule of connective tissue. Nerves derived from the sympathetic system pass to it.

Describe the dura mater. Mention the processes and sinuses of the dura mater.

The *dura mater* is a dense fibrous membrane consisting of two layers and lined on the inner surface by endothelium. It is divided into cranial and spinal portions. The *cranial dura* is adherent to the inner surface

of the cranial wall and performs a double office: it forms the inner periosteum of the skull and also envelops and protects the brain. It is intimately adherent at the line of the sutures and around the foramen magnum, and at the base of the brain and exit of nerves. At definite places the two layers separate and form the *cranial sinuses*. The *spinal dura* invests the cord from the foramen magnum to the third sacral vertebra and supplies a sheath to the spinal nerves where they emerge from the cord.

The *processes* are: the falx cerebri, tentorium cerebelli, falx cerebelli, and the diaphragma sellæ. The *cranial sinuses* are: the superior and inferior longitudinal, straight, circular, and basilar (unpaired); and the lateral, occipital, cavernous, superior and inferior petrosal, and sphenoparietal (paired).

Describe the arachnoid.

It is a delicate membrane, lying between the pia and the dura, which bridges over the convolutions. It consists of interwoven bundles of fibrous and yellow elastic tissue covered with a layer of *endothelium*. The Pacchionian bodies develop from this layer.

Describe the pia mater.

The *pia* is the innermost of the three meninges and forms the immediate investment of the brain and cord. It supports the blood-vessels, dips down into the sulci, and passes into the ventricular cavity. The membrane is thicker and denser in the cord.

Describe the hemispheres and lobes of the brain.

The cerebral hemispheres are ovoid, convex on their superior and lateral surfaces, partially separated from each other by the longitudinal fissure, but connected by the corpus callosum.

Each *hemisphere* has five lobes and eight fissures. The *frontal lobe* is bounded internally by the longitudinal fissure, below by the Sylvian, and posteriorly by the Rolandic fissure. The *parietal lobe* extends from the longitudinal fissure downward to the fissure of Sylvius, and anteroposteriorly, from the fissure of Rolando to the parieto-occipital fissure; the *occipital lobe* lies behind the parieto-occipital fissure; the *temporosphenoidal* occupies the middle fossa of the skull and is bounded in front by the fissure of Sylvius; the *central lobe*, or island of Reil, lies in the fissure of Sylvius, covered by the frontal and temporosphenoidal lobes.

Name the principal lobes of the brain and the fissures dividing them.

Frontal, parietal, temporosphenoid, occipital, and central (island of Reil). The fissure of Rolando separates the frontal from the parietal; the fissure of Sylvius separates the frontal and parietal from the temporosphenoidal lobe; the parieto-occipital fissure separates the parietal from the occipital; and the central lobe lies in the fissure of Sylvius, at the base of the brain.

Give a method by which the fissures of Sylvius and Rolando may be approximately mapped out on the surface of the skull.

Fissure of Sylvius: Draw a line from a point $1\frac{1}{4}$ inches horizontally behind the external angular process of the frontal bone to a point $\frac{3}{4}$ inch below the parietal eminence.

Fissure of Rolando: From a point ½ inch behind the midpoint of a line connecting the glabella and the external occipital protuberance draw a line 3⅜ inches in length, over the side of the head at an angle of 67° with the median line.

Where is the fissure of Sylvius and what artery does it contain?

The fissure separates the frontal and parietal lobes from the temporal; it begins at the anterior perforated space and passes outward and upward to the external surface of the hemisphere. It lodges the middle cerebral artery.

In the anatomy of the brain what is the corpus callosum? Describe its connections?

It is a thick, arched layer of transverse fibers at the bottom of the longitudinal fissure; *anteriorly*, it curves upon itself and gives off two peduncles at the entrance of the Sylvian fissure; *posteriorly*, it is continuous with the fornix. It forms the roof of the lateral ventricles. A median depression on its upper surface is called the *raphe*, parallel to which, on each side, run two or more elevated bands, the *striæ longitudinales* (nerves of Lancisi).

Locate the fourth ventricle of the brain.

It is the space between the posterior surface of the medulla and pons in front, and the cerebellum behind. Lateral boundaries: superior, middle, and inferior peduncles of cerebellum.

Name and bound the ventricles of the brain.

Two lateral, third, fourth, and fifth.

The boundaries are:

Lateral ventricle—roof: corpus callosum; floor: corpus striatum, tænia semicircularis, optic thalamus, choroid plexus, corpus fimbriatum, and fornix; internally, the septum lucidum; externally, the brain substance.

Third ventricle—the roof is formed by the velum interpositum; the lateral walls by the optic thalami and the peduncles of the pineal gland; the floor is formed by the posterior perforate space. The ventricle is limited in front by the anterior crura of the fornix and part of the anterior commissure; behind, by the posterior commissure.

Fourth ventricle—the roof is formed by the valve of Vieussens, the cerebellum, and the inferior medullary velum; the floor is formed by the posterior surface of the medulla and pons; laterally, it is bounded by the superior, middle, and inferior peduncles of the cerebellum.

The *fifth ventricle* is the space between the two layers of the septum lucidum; it is covered by the corpus callosum.

Give the location and the description of the tubercula quadrigemina.

They consist of four rounded eminences on the posterior aspect of the midbrain. The *superior* pair are larger and broader than the *inferior*, and are connected to the brain by tracts of white fibers called brachia. The superior pair give origin to the optic tracts, the inferior to the cochlear division of the eighth nerve. The quadrigemina consist of white matter internally, and gray externally.

Describe the medulla oblongata.

It is the upper, enlarged portion of the spinal cord, extending from the upper border of the atlas or decussation of the pyramidal tracts to the lower border of the pons. The *posterior surface* forms the lower half of the fourth ventricle; its *anterior surface* rests on the basilar groove of the occipital bone. The medulla is divided into two lateral halves by the anterior and posterior median fissures. From the sides of the medulla the ninth, tenth, cranial portion of the eleventh, and twelfth nerves arise. It contains vasomotor, cardiac, respiratory, deglutition, and mastication centers.

The *anterior pyramid* is formed by the crossed and direct pyramidal tracts of the spinal cord; the former decussate at the lower part. To the outer side of the pyramid is the *olivary body*, containing in its interior a capsule of gray matter, the corpus dentatum. The outer portion of the olivary body is in relation with the *lateral tract*, which lies in front of the *restiform body*. The latter is the continuation of the *direct cerebellar tract* and passes above into the corresponding hemisphere of the cerebellum, forming its inferior peduncle. To either side of the posterior fissure lies the fasciculus gracilis. The *fasciculus gracilis* and the *fasciculus cuneatus* represent the continuation of the columns of Goll and Burdach.

Describe the spinal cord.

The *spinal cord* is that part of the cerebrospinal axis which occupies the upper two-thirds of the spinal canal. It is an elongated, cylindric structure, slightly flattened anteroposteriorly, and partially divided by *two fissures*, a shallow anterior and a deep posterior. It extends from the margin of the foramen magnum to the lower border of the first lumbar vertebra and terminates in the filum terminale. The cord is about 16 inches in length. It presents for examination two *enlargements*, the *cervical* and the *lumbar*. The spinal cord gives origin to thirty-one pairs of spinal nerves, each having a ventral and dorsal root.

Structure: In transverse section the gray matter is arranged in each lateral half so as to present a crescentic appearance; the two halves are joined by a commissure. The anterior and posterior extremities are called *horns* and give rise to the spinal nerves, *anterior motor*, *posterior sensory*. In the center of the commissure is the *central canal*, which is continuous above with the fourth ventricle. The white matter surrounds the gray and contains the following tracts: *anterior pyramidal*, between anterior fissure and horn; *lateral tract*, in lateral portion of cord; *posterior tracts*, between the posterior fissure and horn. The *cauda equina* is a bundle of nerves running below the cord, but still within the dura, caused by the foramen of exit being below the cord.

Name the twelve pairs of cranial nerves.

Olfactory, optic, motor oculi, trochlear, trigeminal, abducens, facial, auditory, glossopharyngeal, pneumogastric, spinal accessory, and hypoglossal.

Give the origin and distribution of the olfactory nerve.

The nerves arise from the under surface of the olfactory bulb; they are about twenty in number. They pass through the foramina in the cribri-

form plate of the ethmoid bone to enter the nose, and are distributed as nerves of smell to the upper third of the nasal septum, the roof of the nose, and the superior and middle turbinated bones.

Describe the course of the nerve fibers in the optic commissure.

The fibers upon the posterior surface (Gudden's commissure) have nothing to do with sight; they unite the superior quadrigeminal bodies. The middle fibers decussate, those from the right optic tract passing to the left optic nerve and *vice versa*, to terminate in the nasal half of the retina. The outermost fibers of each tract do not decussate, but pass into the optic nerve of the same side and are distributed to the temporal half of the retina of the same side.

Describe the origin and distribution of the optic nerve.

The nerve arises from the optic commissure, pierces the dura, and passes from the cranial cavity into the orbit, through the optic foramen. In the orbit it is attached to the posterior pole of the eyeball at a point $\frac{1}{8}$ inch on the inner side of the longitudinal axis. The nerve fibers pierce the fibrous and vascular coats to connect with the retina.

Give the function and distribution of the third cranial nerve.

It is the *motor* nerve to all the extra-ocular muscles except the external rectus and superior oblique; it also supplies the iris and ciliary muscle and the motor branch to the ophthalmic ganglion.

State the origin, function, and distribution of the fourth cranial nerve.

Deep origin from the floor of the aqueduct of Sylvius; *superficial origin* from immediately below the inferior corpora quadrigemina. It is the *motor* nerve to the superior rectus muscle.

Name the ganglia connected with the fifth pair of cranial nerves.

Gasserian, ophthalmic, sphenopalatine (Meckel's), otic, and submaxillary.

State the origin of the sensory division of the fifth pair of cranial nerves.

Deep origin from a nucleus in the pons just below the floor of the fourth ventricle; *superficial origin* from the side of the pons.

Give the origin and distribution of the third division of the fifth pair of nerves.

Origin: sensory root from the Gasserian ganglion; *motor root* from the side of the pons Varolii. The roots unite and pass out of the skull through the foramen ovale, immediately dividing into anterior and posterior trunks. The *anterior trunk* gives off branches to the meninges and to the muscles of mastication; the *posterior trunk* divides into the inferior dental, auriculotemporal, and lingual. The inferior dental supplies the mylohyoid muscle and the teeth of the lower jaw; the auriculotemporal supplies the external meatus, parotid gland, temporomaxillary articulation, and temple; the lingual nerve supplies the anterior two-thirds of the tongue.

Give the origin and functions of the trigeminus (fifth cranial) nerve and name the divisions of the same.

It arises from the side of the pons by two roots, a *motor* and a *sensory*. *Functions:* sensory nerve of the head and face, and motor nerve of the muscles of mastication. *Divisions:* ophthalmic, superior, and inferior maxillary. First two divisions are sensory, third is both sensory and motor.

State origin, course, function, and distribution of sixth cranial nerve.

Superficial origin from groove between the anterior pyramid of the medulla and the pons; *deep origin* from the floor of the fourth ventricle. The nerve pierces the dura on the basilar surface of the sphenoid to enter the cavernous sinus, where it lies to the outer side of the internal carotid artery. It enters the orbit through the sphenoidal fissure, passes between the two heads of the external rectus muscle, and terminates in its fibers. *Function:* motor nerve to the external rectus muscle.

Give origin, course, and distribution of the seventh nerve.

Deep origin from a nucleus in the pons; *superficial origin* from the lateral border of the groove between the medulla and the pons. The nerve pierces the dura and enters the internal auditory meatus with the eighth nerve, and, at the bottom of the meatus, it passes into the aqueductus Fallopii. In this canal it traverses the temporal bone, making its exit from the skull through the stylomastoid foramen; it then passes forward in the substance of the parotid gland and divides into numerous branches at its anterior border to supply the buccinator muscle and the muscles of expression. This nerve sends communications to the fifth, eighth, ninth, tenth, and sympathetic nerves.

Where does the glossopharyngeal nerve rise, and what structures are supplied by this nerve and its branches?

Deep origin from the floor of the fourth ventricle; *superficial origin* from the upper portion of the medulla in the groove between the olivary and restiform bodies. The ninth nerve is the nerve of *sensation* to the mucous membrane of the pharynx, fauces, tonsil, and posterior third of the tongue; it also supplies the stylopharyngeus muscle and sends a branch to the tympanum (Jacobson's nerve). It is the nerve of *taste* for the posterior third of the tongue.

What nerves form the pharyngeal plexus?

Pharyngeal branches of the glossopharyngeal, pneumogastric, and cervical sympathetic.

What cranial nerve has the widest distribution?

Pneumogastric (tenth).

Give the four principal points of distribution of the pneumogastric or par vagum nerve.

Jugular fossa, neck, thorax, and abdomen.

Give the deep and superficial origin, course, and distribution of the pneumogastric nerve.

Deep origin from a nucleus in the lower part of the floor of the fourth ventricle; *superficial origin* from the groove between the olivary and restiform bodies, below the glossopharyngeal nerve. It *supplies* the organs of voice and respiration with *motor* and *sensory*, and the pharynx, esophagus, stomach, and heart with motor fibers.

Give the origin and distribution of the eleventh cranial nerve.

It has two origins; one from the side of the medulla, the other from the spinal cord as low down as the fifth cervical nerve. The nerve supplies the sternomastoid and trapezius muscles.

Give the origin and distribution of the hypoglossal nerve.

Deep origin from the floor of the fourth ventricle; *superficial origin* from the groove between the pyramid and olivary bodies of the medulla. The nerve receives fibers from the first cervical nerve, which leave the nerve as the descending hypoglossal and thyrohyoid branches. The twelfth nerve is the *motor* nerve of the tongue.

What nerves supply the tongue?

Motor, hypoglossal; *sensory*, the gustatory branch of the fifth; *taste*, glossopharyngeal, and chorda tympani through anastomosis with gustatory branch of fifth.

What are the nerves of the eyeball?

Optic, motor oculi, and ophthalmic division of fifth (both through ciliary ganglion), and sympathetic fibers from cavernous plexus (also to ganglion).

Describe the phrenic nerve.

Derived from the fourth cervical nerve, it passes downward in the neck, upon the scalenus anticus muscle, and traverses the superior and anterior mediastinum to reach the diaphragm, lying between the pleura and pericardium in front of the root of the lung. *Branches:* muscular (to the diaphragm), pleural, pericardial, inferior vena cava, capsular, and hepatic.

What constitutes the brachial plexus?

The plexus is formed by the anterior primary divisions of the *fifth, sixth, seventh,* and *eighth cervical*, and the *first dorsal* nerves, with a small slip from the fourth cervical. The nerves unite and form *three trunks;* the trunks divide and form *three cords;* from which the terminal nerves are given off. *Branches* arise from the trunks, cords, and nerves.

Describe the musculospiral nerve.

The nerve is one of the terminal branches of the posterior cord of the brachial plexus. The nerve passes from the inner to the outer side of the arm, through the musculospiral groove, and in front of the external condyle; the nerve divides into the *radial* and *posterior interosseus.* The remaining *branches* are muscular, nutrient, and cutaneous.

Give the distribution of the radial nerve below the wrist.

The nerve is entirely cutaneous. It supplies the radial half of the dorsum of the hand, dorsum of thumb, index, middle, and radial half of ring fingers, excepting distal phalanx. Its branches communicate with the musculo-cutaneous nerve and dorsal branch of the ulnar.

Give the origin and distribution of the median nerve.

The nerve is formed by the union of a branch from the inner and one from the outer cord of the brachial plexus and passes down the arm in close relation with the brachial artery. At the bend of the elbow it passes between the two heads of the pronator radii teres to run between the deep and superficial flexors to within 2 inches of the wrist, where it becomes superficial.

The nerve gives off no branches in the arm. In the forearm it supplies the flexors and pronators of the wrist, excepting the flexor carpi ulnaris and one-half of the flexor profundus digitorum; it also supplies the abductor, opponens, and outer head of the flexor brevis pollicis with the two outer lumbricales. It is the *cutaneous nerve of the radial side* of the palm and palmar surface of the thumb, index, middle, and one-half of the ring fingers, also of the last phalanx of the dorsum of the fingers.

Describe the course and distribution of the nerves of the palm of the hand.

The *median nerve* passes under the annular ligament to the ulnar side of the palmaris longus, first giving off a palmar cutaneous which supplies the palmar cutaneous surface of the thumb, index, middle, and one-half of the ring fingers, and then divides into an external and internal branch. The *external branch* supplies the abductor, opponens, and outer head of the flexor brevis pollicis and sends digital branches to the thumb and index fingers. The *internal* sends branches to the two outer lumbrical muscles and digital branches to the contiguous sides of the index and middle, and middle and ring fingers.

The *ulnar nerve* gives off palmar cutaneous branches to the little and ring fingers, and sends a deep palmar branch between the adductor and flexor brevis minimi digiti which follows the deep palmar arch across the palm. In its course it gives off digital branches to the little, and one-half of the ring finger to each interosseous space, and the two inner lumbricales. The nerve terminates by supplying the adductores transversus et obliquus pollicis and the inner head of the flexor brevis pollicis. Articular branches to the wrist are also derived from this nerve.

Describe the sacral plexus and name its branches.

The plexus is formed by the *lumbosacral cord*, the *anterior divisions* of the *upper three sacral*, and part of the *fourth sacral* nerves. The lumbosacral cord, the first, second, and a portion of the third sacral nerves form one division; the remaining part of the third and the fourth form the other division. The *branches* are muscular, superior and inferior gluteal, small and great sciatic, internal pudic, perforating, and cutaneous.

Give the origin, course, and distribution of the great sciatic nerve.

Origin from the lumbosacral cord and first, second, and third sacral nerves. After arising from the above nerves it passes out of the pelvis through the *great sacrosciatic foramen* below the pyriformis muscle, descends between the great trochanter and the tuberosity of the ischium, and passes down the back of the thigh to its lower third, where it divides into the *internal* and *external popliteal*. The nerve sends branches to the hip and knee-joints, and supplies the flexors of the leg.

Give distribution of small sciatic nerve.

The nerve is entirely *cutaneous*, supplies the perineum, scrotum, or labium, and posterior portion of the thigh and leg as far down as the middle of the calf. A few fibers curve around the gluteus maximus and supply the overlying skin.

Describe the sympathetic nerve, naming and locating the principal ganglia.

It consists of a series of ganglia, situated on each side of the vertebral column, and connected together and to the cerebrospinal system by intervening nerves. The sympathetic nerve begins in the ganglion of Ribes, on the anterior communicating artery, and ends in the ganglion impar in front of the coccyx.

The *ganglia* of the sympathetic are: ganglion of the cranium and face, Ribes on the anterior communicating artery, carotid in the carotid canal, cavernous in the sinus of same name. *Cervical: superior*, opposite second and third cervical vertebra behind the carotid sheath; *middle*, on the inferior thyroid artery just to the inner side of the carotid sheath; *inferior*, opposite transverse process of seventh cervical vertebra to inner side of superior intercostal artery.

There are twelve *thoracic*, four *lumbar*, four or five *sacral*, one *coccygeal* ganglia situated in relation with the spinal nerves of same name. There are three *splanchnic nerves*. The *greater* receives branches from the sixth to the tenth thoracic ganglia and terminates in the semilunar ganglion; the *lesser* is derived from the tenth and eleventh dorsal ganglia and terminates in the celiac plexus; the least or *renal* is formed by the twelfth dorsal ganglia and ends in the renal and celiac plexuses.

What is the solar plexus?

The plexus consists of a network of nerves and ganglia lying in front of the aorta and crura of the diaphragm, and surrounding the celiac axis and root of the superior mesenteric artery. The plexus is formed by the greater and part of the lesser splanchnic nerves of both sides, the termination of the right pneumogastric and the two semilunar ganglia.

Compare aponeuroses with tendons.

Aponeuroses are broad, flat sheets of fibrous tissue to which muscular fibers are attached, and serve as tendons of insertion for these fibers. *Tendons* are rounded (cord-like) or narrow (ribbon-like) bundles of fibrous tissue attaching muscles to bones.

What muscles assist in (a) mastication? (b) In deglutition?

(a) Temporal, internal, and external pterygoids, masseter, and buccinator. (b) Mylohyoid, digastric, stylohyoid (first part of act); omohyoid, sternohyoid, sternothyroid, thyrohyoid (second part of act).

Give the origin, insertion, and action of any one of the following muscles: digastric, soleus, and rectus abdominis.

The *digastric* consists of two bellies. The *posterior* belly arises from the digastric groove on the mastoid process; the *anterior* from the mandible close to the symphysis. The two bellies are connected together by a tendon, which is attached to the hyoid bone by a pulley-like band of deep fascia. *Action:* assists in elevating the hyoid bone.

Give boundaries of the anterior triangles of the neck and give the origin and insertion of the muscles forming the boundaries.

The *large anterior triangle* is bounded above by the lower jaw, anteriorly by the middle line of the neck, and posteriorly by the anterior border of the sternomastoid muscle. This triangle is subdivided into three smaller triangles by the anterior belly of the omohyoid and the posterior belly of the digastric.

The inferior or *muscular triangle* is bounded anteriorly by the midline of the neck, behind by the sternomastoid, above by the anterior belly of the omohyoid. The *carotid triangle* is bounded below by the anterior belly of the omohyoid, behind by the sternomastoid, above by the posterior belly of the digastric. The *submaxillary triangle* is bounded anteriorly by the midline of the neck, behind by the posterior belly of the digastric, above by the lower jaw.

Sternocleidomastoid: origin, upper part of the sternum and inner portion of the clavicle; insertion, mastoid process and superior curved line of the occipital bone.

Omohyoid: origin, upper border of the scapula near suprascapular notch; insertion into body of hyoid bone. This muscle has two bellies connected by a central tendon, which is attached to the first rib by a pulley-like band of deep fascia.

Give the origin, insertion, action, and nerve supply of any of the following muscles: superior oblique, masseter, and trapezius.

The *masseter* muscle has two origins, a *superficial* portion from the malar process of the superior maxilla and the anterior two-thirds of the lower border of the zygoma, and a *deep* portion from the posterior third of the lower border and inner surface of the zygoma. The muscle is inserted into the upper half of the ramus and outer surface of the coronoid process of the lower jaw. *Action*: to raise, protract, and retract the lower jaw. *Nerve supply:* inferior maxillary branch of the fifth.

Name the seven muscles of the orbit.

Levator palpebræ superioris, inferior, superior, external and internal recti, superior and inferior oblique.

Give the names of the principal muscles of the back.

Trapezius, latissimus dorsi, rhomboideus major and minor, erector spinæ, and multifidus spinæ.

Locate and describe the quadratus lumborum muscle and give its important relations.

The muscle is situated in the lumbar region and is regularly quadrilateral in shape. It arises by aponeurotic fibers from the iliolumbar ligament and the crest of the ilium; it is inserted into the lower border of the last rib for about half its length, and by four small tendons into the transverse processes of the four upper lumbar vertebræ. The anterior surface of the muscle is in relation with the colon and kidneys.

Name five muscles of the shoulder and give the origin and insertion of any one.

Pectoralis major and minor, deltoid, subscapularis, supra and infraspinatus.

Pectoralis minor: origin from the third, fourth, and fifth ribs near the cartilages; insertion into the coracoid process.

Give the origin, insertion, and action of any one of the following muscles: occipitofrontalis, deltoid, and gastrocnemius.

The *deltoid* arises from the outer third of the anterior border of the clavicle, the outer margin of the acromion, and entire length of the lower border of the spine of the scapula. It is inserted into the deltoid impression upon the outer surface of the middle of the shaft of the humerus. *Action:* to abduct the arm to a horizontal position, and inward and outward rotation.

Give the origin and insertion and blood and nerve supply of the humeral biceps muscle.

Origin: short head from the coracoid process of scapula; long head from the upper margin of the glenoid cavity. The muscle is *inserted* into the tuberosity of the radius and by aponeurosis into the fascia of the forearm. *Blood supply* from the brachial artery. *Nerve supply:* musculocutaneous.

Name and give the origin of the muscles inserted into the greater and lesser tuberosities and edges of the bicipital groove of the humerus.

Inserted into the greater tuberosity are the following muscles: supra- and infraspinatus, and teres minor; into the lesser, the subscapularis; into the bicipital groove, the pectoralis major, teres major, and latissimus dorsi.

The *supraspinatus* arises from the inner two-thirds of the fossa of the same name. The *infraspinatus* from the inner two-thirds of the infraspinatus fossa. The *teres minor* arises from the upper two-thirds of dorsal surface of the axillary border of the scapula and intermuscular septum.

The *subscapularis* arises from the inner two-thirds of the subscapular fossa.

The *teres major* arises from the dorsal aspect of the angle of the scapula and intermuscular septum. The *latissimus dorsi* arises from the spinous processes of the lower six dorsal, all the lumbar and sacral vertebræ, the crest of the ilium, and the angles of the four lower ribs. The *pectoralis major* arises from the lower surface of the inner half of the clavicle, half the breadth of the sternum, and the cartilages of all of the true ribs, excepting the first and seventh.

Name five muscles of the shoulder and arm. Give the origin, insertion, and action of any one of the five.

Deltoid, biceps, tricep teres major, and coracobrachialis.

The *coracobrachialis* arises from the coracoid process of the scapula and inserts into the middle of the inner surface of the shaft of the humerus. *Action:* flexion and adduction of the arm.

Mention any one muscle that moves the humerus (a) forward, (b) backward, or (c) inward.

(a) Coracobrachialis; (b) posterior fibers of deltoid; (c) pectoralis major.

What are the anterior and posterior boundaries of the axilla, and what arteries and nerves pass through it?

Anterior boundary: pectoralis major and minor, costocoracoid membrane; posterior boundary: subscapularis and tendons of teres major and latissimus dorsi.

The *arteries* passing through the space are the axillary and its branches, as follows: superior, thoracic, thoracic axis, alar and long thoracic, anterior and posterior circumflex, and subscapular.

The *nerves* are the brachial plexus, consisting of outer, middle, and inner cords, with the following branches: posterior thoracic, three subscapular, interior and external anterior thoracic, circumflex, musculospiral, musculocutaneous, median, internal, and lesser internal cutaneous.

Mention the flexor muscles of the forearm and describe one of them.

Flexor carpi radialis, palmaris longus, flexor carpi ulnaris, flexor sublimis and profundus digitorum, flexor longus pollicis, pronator radii teres, supinator longus.

The *flexor carpi radialis* arises from the internal condyle by a common tendon with the other flexors from the deep fascia and intermuscular septum; it is inserted into the base of the metacarpal bone of the index finger. *Action:* flexion of the wrist, then of the forearm. *Nerve supply:* the median.

Describe the triangle of the elbow and name the structures that pass through it.

The *antecubital fossa* is bounded above by a line drawn between the two condyles of the humerus, externally by the supinator longus muscle, internally by the pronator radii teres muscle. The *floor* is formed by the brachialis anticus and supinator brevis muscles. The fossa *contains* the brachial, radial, and ulnar arteries and veins, the median and musculospiral nerves, and the tendon of the biceps.

Mention a muscle (a) which moves the thumb outward, (b) which moves the head forward, and (c) which moves the foot inward.

(a) Abductor pollicis; (b) rectus capitis anticus major; (c) tibialis anticus.

Describe the palmar fascia.

The fascia consists of a central and two lateral portions; the central segment, triangular in form, is attached to the annular ligament and divides into four slips opposite the heads of the metacarpal bones; each slip again divides into two to enclose the flexor tendons. Strong transverse fibers connect the separate processes. The lateral portions of this fascia thinly invest the muscles of the thenar and hypothenar eminences.

Name three abdominal muscles and give the origin, insertion, and action of one of them.

External and internal oblique and rectus abdominis.

The *rectus* arises by an inner and outer head from the symphysis and crest of the pubis. It is inserted into the front of the ensiform and the fifth, sixth, and seventh costal cartilages.

What is the linea alba and how is it formed?

It is a tendinous raphe in the middle line of the abdomen, extending from the ensiform to the pubis. It is formed by the blending of the aponeurosis of the oblique and transversalis muscles.

State the action of each of the following muscles: masseter, tibialis anticus, and gluteus maximus.

The *masseter* raises the lower jaw against the upper and also protracts and retracts the jaw; the *tibialis anticus* flexes and inverts the tarsus upon the leg; the *gluteus maximus* is an extensor and an internal rotator of the thigh.

What tissues of the abdominal wall are divided in the operation for appendicitis?

When the incision is made at McBurney's point, the following tissues are divided: skin, superficial fascia, external and internal oblique, and transversalis muscles, transversalis fascia, preperitonal fat, and peritoneum. When the incision is made in the right rectus, the following structures are divided: skin, superficial fascia, sheath of the rectus muscle, rectus muscle, transversalis fascia, preperitoneal fat, and peritoneum.

Describe the diaphragm, its principal openings, and nerve supply.

The *diaphragm* is a musculofibrous partition separating the cavities of the thorax and abdomen. The lower concave surface is in relation with the liver, stomach, and spleen; the upper surface is in relation with the pericardium, pleura, and chest wall. It arises anteriorly from the ensiform cartilage; laterally from the inner surface of the lower six ribs by fleshy bands which interdigitate with the transversalis muscle; posteriorly, from the lumbar vertebræ by two crura.

The *opening* for the vena cava is situated in the right leaflet of the central tendon; the esophageal opening is in the muscular substance behind the central tendon; the aortic opening is situated between the crura and beneath the middle arcuate ligament.

The *nerve supply* is derived mostly from the phrenic, but also from the lower intercostals and sympathetic.

Mention the muscles attached to the great trochanter of the femur.

Gluteus medius and minimus, pyriformis, obturator internus and externus, and superior and inferior gemelli.

What forms the internal hamstrings?

The tendons of the semitendinosus, semimembranosus, and gracilis muscles.

Bound Scarpa's triangle and mention the vessels and nerve in it.

The triangle is bounded *above* by Poupart's ligament—*externally* by the sartorius, *internally* by the adductor longus. The *floor* is formed by the iliacus, psoas, pectineus, adductor brevis, and longus muscles. The *vessels* in the triangle are the common, superficial, and profunda femoris arteries and veins. The anterior crural *nerve* is contained in this triangle.

Describe the vessels, nerves, and other structures found in Scarpa's triangle.

The *femoral artery* divides the triangle into nearly equal parts; it extends from the middle of its base to the apex. It gives off the following *branches:* superficial epigastric, superficial and deep circumflex, iliac, superficial and deep external pudic, and profunda femoris. The *vein* lies to the inner side of the artery and receives the profunda and internal saphenous veins. The anterior crural *nerve* is external to the artery and divides into numerous branches. The triangle also contains fat and lymphatic glands.

(a) Bound Hunter's canal. (b) What passes through it?

(a) The canal is bounded externally by the vastus internus, internally by the adductor magnus; anteriorly these muscles are connected by fascia, upon which the sartorious muscle rests. (b) The superficial femoral vessels and long saphenous nerve.

Bound the popliteal space. Mention its contents.

The space is bounded *above* by the external and internal hamstring muscles; *below*, externally by the plantaris and outer head of the gastrocnemius muscles, internally by the inner head of the gastrocnemius. The *floor* is formed from above downward by the femur, posterior ligament of the knee-joint, fascia covering the popliteus muscle, and the upper end of the tibia. The *roof* is formed by the fascia lata.

The space *contains* the popliteal vessels and branches, the termination of the external saphenous vein, the internal and external popliteal, small sciatic and articular branch of the obturator nerves, and lymphatic glands.

Name the principal muscles that keep the body erect on the thigh and give the origin and insertion of any one of them.

Gluteus maximus, medius, and minimus, tensor fasciæ latæ, and the two obturators. The *gluteus maximus* takes its origin from the outer surface of the ilium between the crest and the superior gluteal line, from the vertebral aponeurosis, from the two last pieces of the sacrum, and the posterior surface of the great sacrosciatic ligament, and is inserted into the gluteal ridge on the femur and iliotibial band of the fascia lata.

What muscles form the quadriceps extensor, and where is its conjoined tendon inserted?

Rectus femoris, vastus internus and externus, and crureus. The tendon is inserted into the tubercle of the tibia.

What muscles form the calf of the leg? Describe any one of these muscles.

Gastrocnemius and soleus. The *soleus* is a broad, flat muscle situated beneath the gastrocnemius. It *arises* by tendinous fibers from the back part of the head of the fibula and upper third of the postero-internal surface of the shaft, from the oblique line of the tibia and middle third of the inner border. The tendons of the soleus and gastrocnemius unite to form the *tendo Achillis*, which is inserted into the os calcis.

Give the origin, insertion, and action of any one of the following muscles: tibialis anticus, pronator radii teres, and gracilis.

The *gracilis* arises by a linear origin from the lower half of the edge of the symphysis pubis, and for a similar distance from the adjoining part of the pubic arch. It is *inserted* on the inner side of the shaft of tibia, just below the inner tuberosity. *Action:* flexor and internal rotator of the leg and an adductor of the thigh.

Name five muscles of the back of the leg.

Gastrocnemius, plantaris, soleus, tibialis posticus, and flexor longus digitorum.

What muscles form the tendo Achillis, and where is the tendon inserted?

Gastrocnemius and soleus. The tendon is inserted into the posterior tuberosity of the os calcis.

Give the names of five muscles of the male perineum.

Ischiocavernosus, compressor urethræ, bulbocavernosus, transversus perinei, and sphincter ani externus.

Where is the compressor urethræ muscle?

It is between the two layers of the triangular ligament and surrounds the membranous urethra.

Describe the sphincter ani externus.

It is a thin flat muscle surrounding the anus and intimately adherent to the surrounding skin. It *arises* from the tip of the coccyx and is *inserted* into the central perineal point. This muscle is peculiar in not having any antagonistic muscle.

Give a general classification of bones and illustrate each class.

Long (femur, humerus); *short* (bones of the carpus and tarsus); *flat* (parietal, sternum); *irregular* (vertebra, sphenoid).

Describe the periosteum.

The membrane which surrounds the bone. It consists of two layers closely united together—the outer layer consists chiefly of connective tissue; the inner layer of elastic fibers, which can be separated into several layers. This membrane supplies the surface of the bone with blood and assists in its growth.

What is the composition of the intervertebral substance? How much of the spinal column does this substance form?

The *intervertebral discs* are composed of laminæ of fibrous tissue and fibrocartilage at the circumference, and soft, pulpy, elastic, fibrous tissue in the center. (b) They form about one-quarter of the total length.

Give a comprehensive description of any one of the long bones of the body.

The *femur* is the longest bone of the skeleton. It consists of a head, shaft, two trochanters, and two condyles. The *head*, which is globular, is directed upward, inward, and forward from the upper end of the shaft. A depression is situated at the center of the upper end of the head for the insertion of the ligamentum teres. The head is joined to the shaft by the *neck*, which forms an angle of about 130° with the shaft in the male, somewhat less in the female.

The *great trochanter* is an irregular eminence directed outward, upward, and backward from the shaft. It gives insertion to the gluteus medius and has a depression on the inner surface (digital fossa). The *lesser trochanter* is a small, conical eminence projecting from the upper back part of the shaft. It gives insertion to the iliopsoas muscle. The anterior and posterior intertrochanteric lines connect these processes.

The *shaft* is triangular at the middle, broad and cylindric at the extremities. The *nutrient foramen* is situated on the posterior surface at the junction of the middle and upper thirds. The *linea aspera* is a prominent longitudinal ridge, situated on the posterior surface of the shaft. It has an external and internal lip.

The lower extremity of the femur is formed by the two *condyles* and the intercondyloid notch, each condyle is convex anteroposteriorly and laterally. The internal condyle is about half an inch longer than the external. Above each condyle is situated a tuberosity. On the inner surface of the lower end of the femur there is a small eminence for the insertion of the adductor magnus.

When (i. e., at what time in life) do the epiphyses join the shaft of the femur?

The lesser trochanter about the eighteenth year, the great trochanter about the nineteenth year, and the lower epiphysis from the twentieth to the twenty-second year.

Mention the sutures at the vertex of the skull and state what bones they unite.

The sagittal suture unites the two parietal bones; the lambdoidal, the occipital with both parietals; the coronal, the two parietal with the frontal.

Name the foramina at the base of the skull and the structures transmitted through each.

Foramen *magnum:* transmits the spinal cord and meninges, the spinal portion of the spinal accessory nerves, and vertebral arteries. *Posterior condyloid* (inconstant): veins, anterior condyloid (two), and hypoglossal nerves. *Mastoid:* emissary vein. *Jugular* foramen: lateral and inferior petrosal sinuses, glossopharyngeal, pneumogastric, and spinal accessory nerves. *Middle lacerated* foramen: nothing. *Carotid canal:* the carotid artery and sympathetic plexus. Foramen *spinosum:* middle meningeal artery. Foramen *ovale:* mandibular division of the fifth nerve. Foramen *rotundum:* superior maxillary division of the fifth nerve. *Vidian canal:* Vidian nerve. *Optic* foramen: optic nerve and ophthalmic artery. *Sphenoidal fissure:* motor oculi, trochlear and abducens nerves, ophthalmic division of the fifth nerve, and ophthalmic vein. *Olfactory* foramina: olfactory nerves.

Name the bones of the head.

Occipital, two parietal, frontal, two temporal, sphenoid, ethmoid, two nasal, two lacrimal, two inferior turbinals, vomer, two palate, two alar, two superior maxillary, and the inferior maxilla.

What bones form the orbital cavities?

Frontal, ethmoid, sphenoid, lacrimal, superior maxillary, palate, and malar.

What bones enter into the formation of the nasal fossæ?

Frontal, sphenoid, ethmoid, two nasal, two superior maxillary, two lacrimal, two palate, two inferior turbinated, and vomer.

Describe the nasal fossæ.

They are two large, irregular cavities situated on each side of the middle line of the face. They extend from the base of the cranium to the roof of the mouth, and are separated from each other by a thin vertical septum. They communicate with the face by the two *anterior nares* and with the pharynx by the two *posterior nares.*

The *roof* is formed by the following bones: nasal, cribriform plate of the ethmoid, body of the sphenoid, sphenoidal process of the palate, and the ala of the vomer; the *floor* by the palatal process of the superior maxilla and the palate bones; the inner wall by a *septum* consisting of the crest of the nasal, the nasal spine of the frontal, the perpendicular plate of the ethmoid, the vomer, the rostrum, and the ethmoidal crest of the sphenoid; the *outer wall* by the nasal, nasal process of the superior maxilla, lacrimal, ethmoid, superior maxilla, inferior turbinated, vertical plate of the palate, and the internal pterygoid plate of the sphenoid.

It has three longitudinal passages (meatus); *superior,* situated between the superior and middle turbinate; opening into it are the sphenopalatine air-cells and the posterior ethmoidal cells. The *middle* meatus is between the middle and inferior turbinate bones; opening into it are the antrum and infundibulum. The *inferior* meatus is between the inferior turbinate and the floor of the nasal cavity; opening into it is the nasal duct.

Name and locate the accessory sinuses of the face.

Frontal, ethmoid, sphenoid, and antrum of Highmore. The *frontal* is situated in the frontal bone beneath the superciliary ridge. The *ethmoid* are interposed between two vertical plates of bone. The outer plate forms part of the orbit, the inner plate part of the nasal fossa. The *sphenoid* cells are two cavities hollowed out of the interior of the body of the sphenoid bone; they are separated from one another by a bony septum. The *antrum* is a cavity hollowed out of the body of the superior maxillary bone.

What are the Wormian bones?

In addition to the constant centers of ossification of the skull a center is occasionally found in the course of the sutures. These form irregular, isolated bones, interposed between the cranial, and have been termed Wormian bones.

Describe the mastoid portion of the temporal bone and name the muscles attached thereto.

The *mastoid portion* is situated at the posterior part of the temporal bone. It is perforated by the mastoid foramina. The interior contains the *mastoid cells*, lined with mucous membrane; these cells are continuous with the tympanum. The conical tip is termed the *mastoid process;* upon the inner side of the process is situated the digastric fossa, parallel and internal to which lies the occipital groove. A deep curved groove exists on the cranial surface for the lodgment of part of the lateral sinus.

The *muscles* attached to the mastoid portion are the occipitofrontalis, retrahens aurium, sternocleidomastoid, splenius capitis, trachelomastoid, and digastric.

Describe the superior maxilla.

The bone consists of a hollow body and four processes. The body is cuboidal in form and hollowed out in the center into a pyramidal cavity, the antrum of Highmore. It has *four surfaces*, an external, which looks forward and outward; a posterior convex surface, which forms part of the zygomatic fossa; a superior surface (orbital plate), which forms part of the floor of the orbit; and an internal, which forms part of the outer wall of the nasal fossa and the mouth. The bone has *four processes:* malar, nasal, alveolar, and palatine. It *articulates* with the following bones: the opposite maxilla, tuberosity of the palate by the posterior outer border, the palate in the floor of the orbit, and the ethmoid, lacrimal, malar, nasal, and inferior turbinated.

Name the articulations of the occipital bone.

Atlas, two parietal, two temporal, and sphenoid.

With what bones does the frontal articulate?

Both parietal, both malar, both nasal, both lacrimal, both maxillæ (superior), ethmoid, and sphenoid.

With what bones does the malar articulate?

Frontal, superior maxilla, temporal, and sphenoid.

Name the articulations of the superior maxillary bone.

With *nine* bones: *two of the cranium,* the frontal and ethmoid; *seven of the face:* nasal, malar, lacrimal, inferior turbinated, palate, vomer, and opposite maxilla.

Mention the muscles and ligaments attached to the ramus of the jaw.

The *muscles* attached to the ramus are the masseter, internal and external pterygoid, buccinator, and temporal. The *ligaments* are the capsular, external and internal lateral of the temporomaxillary articulation, and the stylomaxillary.

Describe the hyoid bone.

The hyoid is a bony arch, shaped like a horseshoe. It consists of five segments: a *body* and two great and two lesser *cornua.* It gives attachment to the sternothyroid, sternohyoid, stylohyoid, digastric, mylohyoid, geniohyoid, geniohyoglossus, and the following ligaments: stylohyoid, thyrohyoid, and the thyrohyoidean membrane.

Describe the sternum, its articulations, and the important muscles attached to it.

The *sternum* is a flat, narrow bone situated in the median line of the front of the chest. It consists of three portions: *manubrium, gladiolus,* and *ensiform cartilage.* It is flattened anteriorly, concave posteriorly, broad above, and becomes narrowed to a point below. The average length is about 6 in. The bone is notched at the superior angles to *articulate* with the clavicle and has seven facets on each lateral border to articulate with the seven upper costal cartilages. Important *muscles* attached to the bone are the sternomastoid, pectoralis major, rectus abdominis, triangularis sterni, sternohyoid, and sternothyroid.

With what bones does the clavicle articulate?

Sternum, scapula, and cartilages of the first rib.

Name the bones articulating with the humerus.

Scapula, radius, and ulna.

With what bones does the radius articulate?

Humerus, ulna, scaphoid, and semilunar.

Name and describe the arrangement of the carpal bones.

They are placed in two rows of four each. Enumerating from the radial to the ulnar side, with the palm upward, *proximal row:* scaphoid, semilunar, cuneiform, pisiform; *distal row:* trapezium, trapezoid, os magnum, and unciform.

Describe the bones of the hand with their divisions and articulations.

The bones of the hand are divided into three classes: carpal, metacarpal, and phalanges. There are *eight carpal* bones: scaphoid, semilunar, cuneiform, pisiform, trapezium, trapezoid, os magnum, and unciform. The carpal articulate with each other, the scaphoid and semilunar with the radius, the cuneiform with the triangular interarticular cartilage between it and the ulna; the trapezium, trapezoid, os magnum, and unciform articulate with the metacarpal bones. The *five metacarpal* bones articulate with those just described, the first row of phalanges, and with each other. The first row of *phalanges* articulates with the metacarpals and the second row of phalanges, the second row with the first and third rows. There are fourteen phalanges. The thumb has only two phalanges.

Give in language or by drawing the normal curvatures of the spinal column, and describe a typical cervical vertebra.

The curves are *cervical*, *thoracic*, *lumbar*, and *sacrococcygeal*. The convexity is forward in the cervical, backward in the thoracic, forward in the lumbar, and backward in the coccygeal. The line of gravity of the trunk passes through the cords of these curves.

A typical cervical *vertebra* consists of a small body, diverging pedicles, a bifid spinous process, and bifid transverse processes which are grooved on the upper border. Each transverse process is perforated at its base by a foramen for the vertebral artery. The neural foramen is relatively large.

Give the number of the cervical vertebræ and mention the marked characteristics of such of these as are in any way peculiar.

Seven.

The *atlas* is formed by two lateral masses joined by an anterior and posterior arch; the anterior arch presents a facet on its posterior surface for articulation with the odontoid process of the axis. Upon the upper surface of each lateral mass is an articular facet which articulates with the occipital condyles; on the inferior surface the facet looks downward and articulates with the axis.

The *axis* has, surmounting the body, the odontoid process, with a facet on the anterior surface for articulation with the atlas and another facet on the posterior surface for the transverse ligament. The odontoid process is roughened at the apex for attachment of the check ligaments.

The *seventh*, or *vertebra prominens*, resembles the other cervical vertebra, except that the spinous process is longer and usually bifid.

Describe one of the vertebræ.

Each vertebra consists of two essential parts, an anterior solid segment or *body* and a posterior segment or *arch*. The arch is formed by two *pedicles* and two *laminæ*, which support seven *processes*, two superior and two inferior articular, two transverse (extending laterally from the pedicles), and a spinous process, the continuation posteriorly of the laminæ.

What bones make up the pelvis? Give the gross anatomy of the bony pelvis.

Two innominate, sacrum, and coccyx. The pelvis is formed by the union of the innominate bones in front and the sacrum behind. It is divided into *true* and *false* by a plane passing through the promontory of the sacrum and the iliopectineal line. The part above this plane (the false pelvis) is formed by the expanding iliac bones. The part below (the true pelvis) is bounded in front by the body and rami of the pubis, posteriorly by the sacrum. Between the sacrum and the spine of the ischium is the great sciatic notch.

What is the chief difference between the male and female pelvis?

In the *female* pelvis the bones are lighter, the muscular impressions less marked, the iliac fossa is broader, and the anterior superior spines are more widely separated. The *pelvic inlet* is larger and more nearly circular, the projection of the sacrovertebral angle is less. The cavity of the pelvis is shallower and wider, the outlet is larger, the coccyx more movable, and the pubic arch wider. The obturator foramen is triangular and smaller than in the male, in whom it is oval.

Describe the bones forming the ossa innominata.

The *ilium* has a curved crest extending from the anterior superior to the posterior superior spine. The internal surface forms the *iliac fossa* (false pelvis, limited below by the iliopectineal line); the external surface is marked by the superior, middle, and inferior curved lines. The *anterior inferior spine* gives attachment to the rectus femoris muscle and the iliofemoral (Y) ligament; it is situated below the superior spine. The ilium forms part of the true pelvis and two-fifths of the acetabulum. It fuses with the os pubis and ischium at the eighteenth to the twentieth year. It *articulates* with the sacrum posteriorly.

The *ischium* has a body; the spine of the ischium projects backward and inward and separates the greater from the lesser sciatic notch. The *lesser sciatic notch* is on the ischium below the spine; the *tuberosity of the ischium* is the lowest part of the pelvis. From the tuberosity the ramus ascends toward the pubic bone and partially bounds the obturator foramen. The ischium forms two-fifths of the acetabulum and part of the true pelvis.

The *os pubis* has a body, a horizontal and a descending ramus; the rami almost bound the obturator foramen. The *pubic spine* is situated at the superior outer angle of the body and gives attachment to Poupart's ligament; the *iliopectineal line* extends from the body along the horizontal ramus; the horizontal ramus is grooved transversely on its under surface by the obturator vessels and nerve.

Describe the acetabulum.

It is a cup-shaped depresion formed by the os pubis, ischium, and ilium. It is bounded by a prominent uneven rim which has a deep notch (cotyloid) on its inferior surface, which is continuous with a circular depression at the bottom of the cavity, to which the ligamentum teres is attached.

Mention the muscular and the ligamentous attachments of the patella.

Muscles: quadriceps femoris; *ligaments:* the anterior (tendopatellar) and the two lateral patellar.

What forms the internal malleolus of the ankle-joint?

The lower end of the tibia.

What forms the external malleolus?

The lower outer end of the fibula.

Describe the bones of the foot, giving their divisions and articulations.

The *tarsal bones* are the os calcis, astragalus, cuboid, scaphoid, internal, middle, and external cuneiform bones; the *metatarsal* bones are five in number; the *phalanges* number fourteen. The *astragalus* articulates with the tibia, fibula, os calcis, and scaphoid. The *os calcis* articulates with the astragalus and cuboid. The *scaphoid* articulates with the astragulus and three cuneiform bones. The *cuneiform* bones articulate with the scaphoid behind each other laterally, and with the first, second, third, and fourth metatarsal bones in front. The metatarsals articulate with the three cuneiform and cuboid behind each other laterally, and the phalanges in front. The first row of *phalanges* articulates with the metatarsals and the second row of phalanges; the second row, with the first and third rows. The great toe has only two phalanges.

What bone forms the heel and with what does it articulate?

The os calcis. It articulates with the astragalus and cuboid.

Give the classification of joints with an example of each.

Synarthrosis or immovable, as in sutures of the skull. *Amphiarthrosis* or slightly movable, as the joints between the vertebræ. *Diarthrosis* or movable, as the knee-joint.

Differentiate synarthrosis, amphiarthrosis, and diarthrosis, giving an example of each.

Synarthrosis is an immovable joint consisting of two bones placed edge to edge with little or no fibrous tissue intervening; example: lambdoid suture. *Amphiarthrosis* is a joint, permitting of slight motion, made up of two bones with an intervening fibrocartilaginous plate or disk, and held together by ligaments; example: joints formed by bodies of the vertebræ and intervertebral disks. *Diarthrosis* is a freely movable joint consisting of two or more bones with articular surfaces covered with hyaline cartilage, lined with synovial membrane, and surrounded by ligaments. *Example:* hip-joint.

Describe the shoulder-joint.

The shoulder-joint is an *enarthroidal* (ball-and-socket) joint formed by the head of the humerus and the glenoid fossa of the scapula. It is lined by synovial membrane which communicates with several of the numerous surrounding bursæ. The *ligaments* are the capsular, which surrounds the margin of the glenoid fossa and is inserted into the upper part of the

neck of the humerus, the coracohumeral, the glenoid, and the long tendons of the biceps muscle. The *nerves* to the joint are the suprascapular, circumflex, and subscapular. The *arteries* are the suprascapular, anterior, and posterior circumflex.

Describe the elbow=joint, name the ligaments, and give their attachments.

The elbow-joint is a *ginglymus* or hinge-joint formed by the trochlear surface of the humerus articulating with the greater sigmoid cavity of the ulna, and the capitellum of the lower end of the humerus articulating with a depression on the head of the radius. The circumference of the head of the radius articulates with the lesser sigmoid cavity of the ulna. The articulating surfaces are covered with a layer of cartilage. The joint is surrounded by a *capsular ligament* which is attached superiorly to the humerus above the articular surface; below, it is attached to the olecranon and coronoid processes of the ulna and the neck of the radius. The external lateral ligament radiates from the external condyle to the outer side of the neck of the radius. The internal lateral ligament is attached above to the inner condyle, below to the inner side of the shaft and olecranon process of the ulna. The orbicular ligament surrounds the neck of the radius and is attached to the margins of the lesser sigmoid cavity.

What ligaments enter into the inferior radio=ulnar articulation?

The triangular fibrocartilage and the anterior and posterior radio-ulnar ligaments.

Describe the wrist=joint.

It is formed by the radius and triangular cartilage above, and the scaphoid, semilunar, and cuneiform bones below. (The ulna is separated from the cuneiform bone by the triangular interarticular cartilage; hence is excluded from the wrist-joint.) The *ligaments* are the anterior and posterior, and the external and internal lateral. The *movements* are flexion, extension, abduction, adduction, and circumduction.

Name the ligaments of the hip=joint.

The ligaments are the capsular, pubofemoral, iliofemoral, ischiocapsular, teres, cotyloid, and transverse.

Describe the hip=joint.

The hip-joint is an *enarthroidal* or ball-and-socket joint. The joint consists of the head of the femur resting in the *acetabulum* and surrounded by the *capsular ligament.* The acetabulum is incomplete below for entrance of vessels and nerves. Both the head and the acetabulum are covered by articular cartilage. The capsular ligament is assisted by the following *ligaments* (Y) or iliofemoral, cotyloid, transverse, pubofemoral, and ischiofemoral. The joint has the following *movements:* flexion, extension, adduction, rotation, and circumduction. The *arteries* supplying the joint are derived from the obturator, sciatic, internal circumflex, and gluteal. The *nerves* supplying the joint are derived from the sacral plexus, the great sciatic, obturator, accessory obturator, and anterior crural nerves.

Describe the Y or iliofemoral ligament.

It is a band of fibers extending obliquely across the front of the hip-joint and is intimately connected with the capsular ligament. The ligament is attached *above* to the anterior inferior spine of the ilium and diverges *below* to form two bands: one passes downward, to be *inserted* into the lower part of the anterior intertrochanteric line, the other passes downward and outward, to be *inserted* into the upper part of the interior intertrochanteric line.

Describe the structure of the knee-joint.

The joint is a *ginglymus* or hinge-joint, and consists of three articular surfaces, one between each condyle of the femur and the tibia, also one between the femur and the patella. The surfaces between the femur and the tibia are separated by two *semilunar fibrocartilages*. The joint is surrounded by a *capsular ligament*, strengthened by an anterior and posterior and an external and internal lateral. Within the joint are the following *ligaments:* anterior and posterior crucial, transverse, and coronary. The *blood supply* is derived from the anastomotica magna, popliteal, anterior tibial, and external circumflex arteries. The *nerve supply* is derived from the obturator, anterior crural, external, and internal popliteal nerves. *Actions:* flexion, extension, and slight rotation.

Name the bones that form the ankle-joint and give their relations.

The *tibia*, *fibula*, and *astragalus*. The astragalus rests in a cavity formed by the lower end of the tibia above, by the internal malleoli of the tibia internally, and by the lower end of the fibula externally.

Name the ligaments of the ankle-joint.

Anterior and posterior, internal and external lateral.

What is connective-tissue? Where in the body is connective-tissue found?

By the term connective-tissue we mean a number of tissues which possess the following feature in common: that they serve the general purpose in the animal economy of supporting and connecting the tissues of the frame. The principal forms are *white fibrous*, *yellow elastic*, and *areolar*. It is distributed throughout the body and forms the sheaths of muscles, blood-vessels, and nerves, also ligaments, tendons, etc.

Describe the gross anatomy of the larynx.

The *larynx* is the organ of voice, situated at the upper part of the air-passage. It is situated between the trachea and the base of the tongue, in the upper and fore part of the neck, where it forms a considerable projection in the middle line. Behind, it forms part of the anterior boundary of the pharynx, and is covered by the mucous membrane lining that cavity. The larynx is broad above, where it presents the form of a triangular box, flattened behind and at the sides; below it is narrow and cylindric. It is composed of the following *cartilages:* thyroid, cricoid, epiglottis, two arytenoid, two cornicula, and two cuneiform. The cartilages are connected together by ligaments and moved by numerous muscles. The interior

is lined by mucous membrane. The superior aperture is wide in front and narrow behind; it is bounded above by the *epiglottis*. The cavity of the larynx extends from the superior aperture to the lower border of the cricoid cartilage and is divided into two parts by the *true vocal cords*. The space between the true cords is called the *glottis*, the boundary of which is called the rima glottidis. The true cords extend from the angles of the arytenoid cartilages to the receding angle of the thyroid; above the true cords are the *false;* between them is a cavity called the *ventricle of the larynx.*

The *blood supply* is derived from the superior and inferior thyroid. The *superior laryngeal nerve* pierces the thyrohyoid membrane and supplies sensation to the interior of the organ; the *recurrent laryngeal* is the motor nerve to all the muscles excepting the cricothyroid, which is supplied by the superior laryngeal.

Name and locate the cartilages of the larynx.

Thyroid, cricoid, epiglottis, two arytenoid, two cuneiform, and two cornicula. The *thyroid* consists of two alæ united in front at an acute angle; the upper border is attached to the hyoid bone by the thyrohyoid membrane, the lower border articulates with the cricoid on each side and is connected to the cricoid by the cricothyroid membrane anteriorly. The *cricoid* is ring-shaped and united to the thyroid as given above. Its lower border is connected to the upper ring of the trachea by a fibrous membrane. The *arytenoids* are triangular, and rest on the posterior upper surface of the cricoid. The *epiglottis* is placed behind the tongue, in front of the superior opening of the larynx; the anterior portion is free; the posterior portion is connected to the angle between the thyroids by the thyro-epiglottic ligament. The *cornicula* surmount the apices of the arytenoid cartilages. The *cuneiform* are contained in the aryteno-epiglottidean folds.

Describe the arytenoid cartilages.

They are *two* in number, and each is situated at the upper border of the lamina of the cricoid cartilage. Each cartilage is pyramidal in form and presents for examination three surfaces, a base, and an apex. It *articulates* with the cricoid and cartilages of Santorini, and gives attachment to the true vocal cords and the following muscles: crico-arytenoid, arytenoid, and thyro-arytenoid.

Give the anatomy of the true vocal cords.

The *true vocal cords* are placed below the false cords; they extend from the angle between the alæ of the thyroid cartilages to the vocal processes of the arytenoid cartilages. The cord is sharp and prominent; the investing mucous membrane is covered by stratified squamous epithelium.

What structures are severed in tracheotomy?

Skin, superficial and deep cervical fascia. The sternothyroid muscle is separated from its fellow and the pretracheal fascia and tracheal rings are divided.

Describe the pleura.

The *pleura* is a serous membrane covering the lungs (visceral layer), thoracic surface of the diaphragm, and the inner surface of the wall (parietal layer).

Give the boundaries of the anterior mediastinum.

It is bounded *in front* by the sternum, *on each side* by the pleura, *behind* by the pericardium, *below* by the diaphragm, *above* by an imaginary line extending from the junction of the first and second pieces of the sternum to the fourth dorsal vertebra.

What is contained in the middle mediastinum?

The heart enclosed in the pericardium, ascending aorta, lower part of superior cava, upper portion of vena azygos major, pulmonary arteries and veins, phrenic nerves, and lymphatic glands.

Give the boundaries and mention the contents of the posterior mediastinum.

It is bounded *in front* by the pericardium and root of the lungs, *behind* by the vertebral column, *laterally* by the pleuræ. The *contents* are the descending thoracic aorta, greater and lesser azygos veins, pneumogastric and splanchnic nerves, esophagus, thoracic duct, and lymphatic glands.

Describe the trachea.

The *trachea* is a cartilaginomembranous cylindric tube, slightly flattened posteriorly. It is kept patent by a series of *cartilaginous rings*, which are deficient posteriorly. It begins above at the lower border of the cricoid, opposite the sixth cervical vertebra; from this point it extends downward through the lower part of the neck into the superior mediastinum, ending opposite the fifth dorsal vertebra by dividing into right and left bronchus. The caliber is variable; it exhibits a slight dilatation about the middle, and another at the bifurcation.

Give an anatomic description of the bronchial tubes.

They are two tubes, structurally like the trachea, extending from its bifurcation into the lungs, dividing and subdividing, and gradually losing their cartilaginous character, until the diameter of one-fourth of a line is reached, when they become entirely membranous. The tubes are lined by ciliated columnar epithelium. The *right bronchus* is wider, about 1 in. shorter, and more horizontal than the left. The *blood supply* is derived from the inferior thyroid and aorta. The veins empty into the thyroid plexus and the lymphatics into the bronchial glands. The *nerves* are branches of the pneumogastric and sympathetic.

Describe the lungs.

The *lungs* are the essential organs of respiration; they are two in number, one on each side of the chest. Each lung is conical in shape and presents for examination an apex, a base, two borders, and two surfaces. Each lung is divided into two *lobes* by a long fissure, which extends from the upper part of the posterior border downward and forward to the lower part of the anterior border. The upper lobe of the right lung is partially subdivided by a short fissure. The root of the lung is situated above the middle of the inner surface and nearer the posterior border. The root of the lung is formed by the bronchial tube, pulmonary and bronchial arteries and veins, pulmonary nerves, and lymphatics.

Structure: The lung is composed of an external serous coat (visceral layer of the pleura), subserous areolar tissue which invests the surface of the lung, and the parenchyma. The parenchyma is composed of *lobules* closely connected together by interlobular areolar tissue. Each lobule is composed of one of the ramifications of a bronchial tube with the terminal *air-cells*, and the ramifications of the pulmonary and bronchial vessels, lymphatics, and nerves. The lungs receive *blood* through the bronchial arteries for their own *nutrition*, and venous blood through the pulmonary artery for *aëration.* The bronchial veins empty on the right side into the vena azygos major, on the left into the superior intercostal. The *nerve supply* is derived from the anterior and posterior pulmonary plexus.

Name the subdivisions of the alimentary canal and give the name and location of the various glands found in the small intestine.

Mouth, pharynx, esophagus, stomach, duodenum, jejunum, ileum, ascending, transverse, descending and sigmoid colon, rectum, and anus.

The *glands* in the small intestine are: duodenal ("Brunner's"), found in the duodenum; intestinal follicles ("crypts of Lieberkühn"), found in the whole length of the small and large intestine; and solitary glands and Peyer's patches, found in all parts of the small intestine, but most numerous in the ileum.

Describe the tongue.

The *tongue* is a large mobile mass composed chiefly of muscular tissue and covered by mucous membrane. It occupies the floor of the mouth and forms the anterior wall of the oral pharynx. The sense of taste resides chiefly in its modified epithelium. The tongue is also an important organ of speech and assists in the mastication and deglutition of the food.

Describe the tonsils and name some of the arteries which supply them with blood.

The *tonsils* are placed between the anterior and posterior palatine arches in the tonsillar recess, close to the base of the tongue. They vary greatly in size and shape. Their surface is irregular and marked by numerous depressions leading into *crypts* in the substance of the tonsil; the crypts are surrounded by follicles of lymphoid tissue. The *arteries* that supply the tonsils are the dorsalis linguæ, ascending palatine, tonsillar branches of the facial, descending palatine of the internal maxillary, and the ascending pharyngeal.

Describe the pharynx.

The *pharynx* is the upper portion of the digestive tube. It communicates with the mouth, larynx, nasal cavities, Eustachian tubes, and esophagus. It extends from the base of the skull to the sixth cervical vertebra (lower border of cricoid cartilage). It is divided into the nasal, oral, and laryngeal pharynx. The pharynx is a musculomembranous sac about four inches in length, broader transversely than anteroposteriorly. In the nasal pharynx are situated the *pharyngeal tonsils* and the *orifices of the Eustachian tubes;* the space posteriorly to the tubes in the lateral wall is

called the lateral recess (*fossa of Rosenmüller*). The oropharynx is the portion between the soft palate and the superior border of the larynx; it contains the *faucial tonsil.* The laryngeal pharynx is that portion situated behind the larynx; it contains the *sinus pyriformis.* The *blood supply* is derived from the internal maxillary and facial arteries. *Nerve supply* is derived from the ninth and tenth nerves and the sympathetic system.

Name the seven openings into the pharynx.

Larynx, mouth, esophagus, two Eustachian tubes, and two posterior nares.

Describe the esophagus as to (a) location, (b) dimensions, and (c) arterial supply.

The esophagus extends from the cricoid cartilage to the cardiac end of the stomach. In the neck it lies between the trachea and the vertebral column and longus colli muscle; in the lower part of the neck it inclines to the left, having on each side the common carotid artery and the lateral lobe of the thyroid gland. The recurrent laryngeal nerves ascend between the esophagus and the trachea. In the thorax the esophagus is at first slightly to the left; after passing posterior to the aortic arch it descends in the posterior mediastinum along the right side of the aorta to the diaphragm, where it passes in front previous to entering the abdomen.

(b) In *length* it usually measures about 10 in. (25 cm.). Its *breadth*, where the tube is widest, varies between ½ in. (13 mm.) in the empty contracted condition and 1 in. or more (25 to 30 mm.) in the fully distended state.

(c) The *arterial supply* is derived from the inferior thyroid, descending aorta, and gastric branch of the celiac axis.

Describe the stomach, give its average size, attachments, regional location, gross structure, and blood supply.

The *stomach* is irregularly pyriform in shape, with a wide or *cardiac end* directed backward and to the left, and a narrow *pyloric end* which extends to the right to join the duodenum. In addition to its two ends, the stomach presents for examination the following parts: two curvatures, greater and lesser, which separate the superior and inferior surfaces; and two orifices, the esophageal orifice or cardia and the pyloric orifice or pylorus. Probably no organ in the body varies more in *size*, within the limits of health, than the stomach. Consequently it is difficult, perhaps impossible, to arrive at a correct estimate of its size and capacity. The length in the fully distended condition is about 10 to 11 in. (25 to 27 cm.), and its greatest diameter not more than 4 to 4½ in. (10 to 11 cm.). The *capacity* of the stomach in the average state rarely exceeds 40 oz., or 1 quart.

The stomach is *attached* to the spleen by the gastrosplenic omentum, to the diaphragm by the gastrophrenic ligament; the lesser curvature is attached to the under surface of the liver by the lesser omentum. It is *located* in the left hypochondriac, epigastric, and part of the right hypochondriac regions. The stomach is composed of four coats—namely, from without inward: (1) peritoneal, (2) muscular, outer longitudinal, middle circular, and inner oblique, (3) submucous, and (4) mucous membrane.

Blood-vessels: The arteries of the stomach are all derived ultimately from the celic axis. The gastric direct, the pyloric from the hepatic, the right gastro-epiploic from the gastroduodenal, the left gastro-epiploic and vasa brevia from the splenic.

Describe the pyloric orifice of the stomach.

The *pylorus* is the aperture through which the stomach communicates with the duodenum. It is marked externally by a circular constriction, the sulcus pyloricus, and interiorly by a prominent thickening of the wall. The pyloric valve is produced by a special development of the circular muscular fibers known as the *pyloric sphincter.*

Into what, and how far from the pyloric orifice of the stomach, does the ductus communis choledochus normally open?

The common duct empties into the duodenum (descending portion) upon its concave side, 3 or 4 in. below the pyloric orifice.

Mention the ligaments, fissures, and lobes of the liver.

The *ligaments* are five in number, falciform (suspensory), round, coronary, and right and left lateral. The *fissures* are the fissure for the round ligament (obliterated umbilical vein), for the gall-bladder, for the ductus venosus, for the inferior cava, and the transverse fissure. The *lobes* are the right, left, quadrate, spigelian, and caudate.

Locate and briefly describe the gall-bladder.

It is a pear-shaped, fibromuscular *receptacle for the bile.* The fundus, under surface of the body, and neck of the gall-bladder are covered with peritoneum. The *length* is from 3 to 4 in,, *capacity* 8 to 12 dr. The gall-bladder lies in a fissure on the under surface of the liver, with the fundus, its most dilated portion, projecting slightly beyond the anterior border at the ninth costal cartilage. It is lined with cylindric epithelium and marked by numerous rugæ. It empties into the cystic duct.

Give the gross and the topographic anatomy of the pancreas.

The *pancreas* is a compound racemose gland from 6 to 8 in. long by 1 in. wide. It is composed of a number of *lobules*, each lobule consisting of an ultimate branch of the pancreatic duct lined with columnar epithelium and surrounded by a capillary network of blood-vessels. The *pancreatic duct* (Wirsung) extends the whole length of the gland and opens into the middle of the descending duodenum with the common bile-duct; the accessory duct (Santorini), when present, opens into the duodenum about 1 in. above the former. The *head*, or right extremity, is embraced by the concavity of the duodenum, the *tail* rests on the spleen above the left kidney, the *body* is covered by the ascending layer of the transverse mesocolon and posterior surface of the stomach; the superior mesenteric artery and vein, portal vein, inferior vena cava, and aorta separate it from the first lumbar vertebra.

The *blood supply* is received from the following arteries: the splenic and right and left pancreaticoduodenal. The *nerves* are derived from the celiac axis and splenic plexus of the sympathetic.

Describe the great omentum.

The great omentum consists of *four layers*, two anterior and two posterior. The middle layers constitute the wall of the lesser sac, the two external belong to the greater peritoneal cavity. Only in fetal life can these layers be separated. Until the age of two years there exists between the two inner layers a cavity. The omentum resembles a four-cornered curtain. It hangs down from the greater curvature of the stomach in front of the small intestine; posteriorly it is fused with the transverse colon. Its vessels, the *vasa epiploica*, are derived from the right and left gastro-epiploica; the *nerves* from the celiac plexus.

Describe the mesentery.

When the peritoneum on the vertebral column reaches the anterior surface of the superior mesenteric vessels it follows them down to the loops of small intestine, surrounding all the jejunum and ileum, but not the duodenum, and returns to the vertebral column. This peritoneal reflection is called the *mesentery* and serves to support the intestines. It has a right upper and a left lower layer, between which are the mesenteric arteries and veins, lacteals, lymphatics, nerves, and fat. The origin of the two layers is called the *root* of the mesentery; it extends from the left side of the body of the second lumbar vertebra to the right sacro-iliac articulation.

Locate and describe the ileocecal valve.

It is formed by two horizontal semilunar folds of mucous membrane at the *termination of the ileum* in the cecum. The valve opens toward the large intestine and guards against reflux from the large into the small bowel; the mucous folds are reinforced by circular muscle fibers.

Locate and describe the cecum.

The *cecum* lies in the right iliac fossa above the outer half of Poupart's ligament, and is that part of the large intestine situated below the ileocecal valve. It has longitudinal bands, sacculations, and three coats, like every other part of the large intestine. It is usually surrounded by peritoneum. The *appendix* arises from the lower portion. Treves gives four types of ceca: First, the *fetal* type, which is conical, with the appendix rising from its apex in line with the axis of the colon. Second or quadrate type in form—the appendix is in the center of two sacculi of equal size at the termination of the longitudinal bands. In the *third* type the right saccules and anterior wall have grown longer and larger than the left saccule and posterior wall, causing a bulging of the right side; the appendix arises from the true apex, not the one caused by the extra length of the right side. The *fourth* type is an exaggerated condition of the third.

Describe and give the anatomic relation of the appendix vermiformis.

It is a worm-like tubular outgrowth which springs from the inner and posterior surface of the cecum, about 1 in. below the ileocecal orifice. It may point in any direction, but usually in one of the following: over the brim of the pelvis into the pelvis, upward behind the cecum, upward and

inward toward the spleen. The *size* varies: it is usually about 3½ in. long by ¼ in. thick. The lumen also varies, being largest in the young and smallest in the old. It is covered with peritoneum, which forms a *meso-appendix* at the lower border. The *structure* is the same as the large intestine—namely, serous, muscular (longitudinal and circular), submucous and mucous; it contains lymphoid nodules.

Locate and describe the rectum.

The *rectum* begins at the termination of the pelvic mesocolon, at the level of the third sacral vertebra, and ends where the bowel pierces the pelvic floor, which is a point 1½ in. in front of, but at a lower level than the tip of the coccyx. It first descends along the front of the sacrum and coccyx, following the curve of these bones; beyond the coccyx it rests on the pelvic floor. The rectum resembles the large bowel, except that it is only partially covered with peritoneum. It is formed by the same coats and has longitudinal bands and sacculations. *Houston's valves* are infoldings of the lateral wall caused by the shortness of the anterior and posterior longitudinal bands. If the *anal canal* is included as part of the rectum, then there are the *columns of Morgagni*, which are vertical folds of mucous membrane. If a probe is passed downward between two columns of Morgagni it will catch in a small crescentic fold which joins the lower ends of the columns; these are the *anal valves*. Usual length of rectum from 5 to 6 in.

State (a) the nerve supply of the rectum and (b) the blood supply of the rectum.

(a) Sympathetic branches from the inferior mesenteric, and hypogastric plexus. Cerebrospinal fibers from the third, fourth, and fifth sacral nerves, also inferior hemorrhoidal branch of the internal pudic.

(b) Superior and middle hemorrhoidal arteries, branches of inferior mesenteric, and anterior trunk of internal iliac, respectively; inferior hemorrhoidal, branch of internal pudic.

Describe the ischiorectal fossæ and their contents.

The *fossa* is situated between the lower end of the rectum and the tuberosity of the ischium. The space is *triangular* in shape; the base, which is directed toward the surface of the body, is formed by the integument of the ischiorectal region; the *apex* is directed upward and corresponds to the point of division of the obturator fascia and anal fascia; the *internal boundary* is formed by the anal fascia covering the levator and sphincter ani muscles; the *external boundary* is formed by the tuberosity of the ischium and obturator fascia covering the obturator internus muscle; the space is limited *in front* by the line of junction of the superior and deep perineal fasciæ; *behind* by the margin of the gluteus maximus muscle and great sacrosciatic ligament.

In the outer wall of the fossa the internal pudic vessels and nerve are inclosed in a sheath of obturator fascia (Alcock's canal). The ischiorectal space is filled with adipose tissue and crossed anteriorly by the superficial perineal vessels and nerve, in the middle by the inferior hemorrhoidal vessels and nerve, posteriorly by the fourth sacral nerve.

Locate and name the apertures in the walls of the abdomen and the structures passing through them.

The *external abdominal ring* is situated above and to the outer side of the os pubis in the aponeurosis of the external oblique muscle; it transmits the spermatic cord in the male and the round ligament in the female. The *internal abdominal ring* is situated in the transversalis fascia midway between the anterior superior spine of the ilium and the spine of the pubis; it transmits the spermatic cord in the male and the round ligament in the female. Openings in the diaphragm: the *aortic opening* is between the crura of the diaphragm and transmits the aorta, vena azygos major, and thoracic duct. The *quadrate foramen* is in the right lobe of the central tendon and transmits the inferior vena cava. The *esophageal opening* is in the muscular substance behind the central tendon; it transmits the esophagus and pneumogastric nerves.

Name the abdominal viscera wholly covered with peritoneum; those partially covered.

(a) Cecum, appendix, jejunum, and ileum.

(b) Liver, spleen, kidneys, suprarenal capsule, colon, duodenum, pancreas, stomach, rectum, uterus, ovary, and bladder.

Locate and describe the spleen.

The *spleen* is a soft, spongy, very vascular ductless gland, about 5 by 3 by 2 in. in length, breadth, and thickness and weighs from 6 to 10 oz. It is situated in the left hypochondrium, between the fundus of the stomach, diaphragm, and colon, and is attached to the diaphragm and stomach by folds of peritoneum. The *hilum* is a vertical fissure on the concave surface for the entrance of the vessels and nerves. *Structure:* The gland is covered almost entirely by peritoneum, and is encased in a fibro-elastic *capsule* which is reflected inward at the hilum to form the framework of the organ. This framework supports the *splenic pulp* comprising connective-tissue cells, pigment granules, red blood-cells in all stages of disintegration, and Malpighian bodies. The *Malpighian bodies* are masses of lymphoid tissue surrounding the splenic capillaries.

Describe the thymus gland.

The *thymus* attains its maximum development toward the end of the second year; from this time on it dwindles away until only a comparatively small portion is left. In the newborn child it is of a pinkish color, and is composed of *two lateral lobes* separated by a *fissure.* The main portion of the gland is placed in the superior and anterior mediastinum; as a rule, it extends downward as far as the fourth costal cartilage. *Structure:* The thymus is composed of a large number of small polyhedral lobules; each lobule is composed of a cluster of lymphoid follicles with a small amount of delicate connective tissue intervening between them. Contained in the follicles are the concentric *corpuscles of Hassall.* These corpuscles are composed of flattened cells arranged concentrically around a granular nucleated cell. The gland is surrounded by a fibrous sheath which sends prolongations between the different lobules.

What are the suprarenal capsules and what are their relations to adjacent organs and parts?

They are two triangular organs which lie one on either side of the vertebra in intimate relation with the upper end of the corresponding kidney. In structure they consist of a fibrous network supporting glandular tissue; the gland substance is composed of an external *cortical layer* which is firm in consistence, of a yellow hue, and forming the chief bulk of the organ; and an internal *medullary layer*, very soft and pulpy in consistency and dark in color. The *left suprarenal* rests on the superior and inner surface of the left kidney, the anterior surface is in relation with the posterior surface of the stomach and pancreas, the posterior surface is in relation with the left crus of the diaphragm and left kidney. The *right suprarenal* rests by its base upon the anterior and inner aspect of the right kidney; it is situated between the posterior surface of the right lobe of the liver and that portion of the diaphragm which covers the side of the vertebra; the vena cava rests on the inner surface.

Name the regions of the abdomen.

Right and left hypochondrium, epigastrium, right and left lumbar, umbilical, right and left iliac, and pubic.

Where in the topography of the abdomen is the sigmoid flexure located? The appendix vermiformis?

(a) In left iliac and hypogastric regions. (b) In right iliac region.

What anatomic parts are normally found in the left hypochondriac region?

Fundus of stomach, spleen, and tail of the pancreas, splenic flexure of the colon, upper part of the left kidney.

What is contained in the right hypochondriac region?

Portion of the liver, the gall-bladder, the hepatic flexure of the colon, and the upper part of the kidney.

What is found in the right iliac region.

Last part of the ileum, the cecum, and appendix.

Describe Poupart's ligament, naming its anatomic relations and uses as a surgical guide.

Poupart's ligament is the lower border of the aponeurosis of the external oblique muscle. The ligament extends from the anterior superior spine of the ileum to the spine of the os pubis; from this latter point it is reflected outward to be attached to the pectineal line for about ½ in. The reflected portion is called *Gimbernat's ligament*. The lower border is continuous with the fascia lata of the thigh. The ligament forms the lower boundary of the *inguinal canal* and the outer pillar of the *external ring*, also the inner boundary of the *femoral canal*. Beneath the ligament are found, from without inward, the external cutaneous and anterior crural nerves, femoral artery, and vein. It is the guide in inguinal hernia and in ligation of the external iliac and femoral arteries.

Describe the internal abdominal ring.

The ring is an *oval opening* in the transversalis fascia midway between the anterior superior spine and the pubis, ½ in. above Poupart's ligament. The ring is *bounded* above and externally by the transversalis muscle, below and internally by the deep epigastric vessels. It *transmits* the spermatic cord in the male and the round ligament in the female. It is covered by infundibuliform fascia.

Describe the inguinal canal.

It is a flat-sided passage in the lower part of the inguinal region, extending between the internal and external abdominal rings; the *floor* is formed by the transversalis fascia and the conjoined tendon, the *roof* by the external oblique muscle. It is about 1½ in. long in the adult. It *contains* the spermatic cord in the male and the round ligament in the female.

Give the surgical anatomy of femoral hernia.

A femoral hernia descends through the femoral ring (the inner compartment of the femoral canal), carrying with it the septum crurale; it descends until it reaches the cribriform fascia, which it pierces, and becomes superficial. The *coverings of the hernia*, from without inward, are skin, superficial and cribriform fascia, crural sheath, septum crurale, preperitoneal fat, and peritoneum.

Give the location and describe the anatomic structure of the kidneys.

The *kidneys* are situated in the lumbar region and rest upon the psoas magnus and quadratus lumborum muscles. The upper end of the left kidney reaches as high as the upper border of the eleventh rib, the upper end of the right as high as the lower border of the eleventh rib. Each is capped by a suprarenal body. The kidney is surrounded by a *capsule* and a perirenal connective-tissue containing fat; it is supplied by the renal artery and drained by the renal vein and lymphatics. The nerves are derived from the renal plexus of the sympathetic system.

The kidney is bean-shaped, the notch upon the inner border is called the *hilum*, and leads into a depression or cavity known as the *sinus*. In the sinus the *ureter* begins and the vessels and nerves enter or leave. The interior of the gland consists of a connective-tissue, parenchyma supporting vessels, and uriniferous tubules. It is subdivided into the *cortex* and the *medulla*. The cortex contains the *glomeruli* (coiled-up blood-vessels) and some of the tubules; the medulla consists of *pyramids* (Malpighian or medullary) made up of parallel collecting tubules, which terminate upon the apex of the pyramid and pour the urine into the calices of the *pelvis of the kidney*. The uriniferous tubules begin around a glomerulus as a closed extremity (capsule of Bowman), and pass tortuously through the cortex (loop of Henle), terminating in one of the collecting tubules found in the pyramid of Ferrein.

Describe the arteries and veins passing to and from the kidneys.

The *arteries* spring nearly at a right angle from the sides of the aorta below the superior mesenteric branch; the right is longer than the left and

passes behind the inferior vena cava, each dividing into four or five branches before entering the hilum. The *veins* pass out of the hilum, transversely across the abdomen to the inferior vena cava; the left is the longer, and passes in front of the aorta; it also receives the left spermatic vein. Relation of structures at the hilum from before backward: vein, artery, ureter.

Describe the renal blood circulation.

The arterial blood enters the sinus through the hilum by means of the renal artery, the branches of which pass between the Malpighian pyramids to the corticomedullary junction, where they form transverse branches which in turn send arterioles into the cortical and medullary portions, forming glomeruli in the former and plexuses around the uriniferous tubules in the latter. The veins collect the blood from the cortex and medulla and form corticomedullary veins which pass through the medullary portion between the pyramids and leave the kidney through the sinus as the renal vein.

Give the relations of the right kidney.

It extends *from the eleventh rib* nearly *to the iliac crest;* the *anterior* surface is in relation with the right lobe of the liver, descending portion of the duodenum, and ascending colon; the *posterior* surface rests on the right crus of the diaphragm, the transversalis aponeurosis separates it from the quadratus lumborum muscle. It is capped by the suprarenal capsule.

Give the course and relations of the ureters in the male and female.

The course of the *ureter* is divided into the abdominal and pelvic portions. The *abdominal portion*, about 5 in. in length, is directed downward and slightly inward, and lies upon the psoas muscle. On both sides the spermatic or ovarian vessels pass in front and the genitocrural nerve behind; on the right side the descending duodenum lies in front of the upper part and the line of attachment of the mesentery crosses it lower down. On the left side the line of attachment as the mesentery of the pelvic colon crosses the ureter. The *pelvic portion* is about 4 in. in length and passes downward on the lateral wall of the pelvis. In its course within the pelvis the ureter lies in front of the internal iliac artery and crosses the inner aspect of the obturator nerve and vessels and the hypogastric artery. About the level of the ischial spine the ureter bends somewhat inward above the fascia of the pelvic floor to reach the bladder. In this position it is crossed by the *vas deferens*. A little further on in its course the ureter is in relationship with the upper end of the *vesicula seminalis* and passes in front of it to the bladder wall. When the right and left ureters reach the bladder they are about 2 in. apart. They pierce the bladder wall very obliquely and are imbedded within its muscular tissue for nearly $\frac{3}{4}$ in. They finally open into the bladder by two small slit-like apertures which are of a valvular nature and prevent a backward passage of fluid from the bladder. *In the female* the ureter, near its termination, passes beneath the lower part of the broad ligament and lies to the outer side of the cervix uteri and upper part of the lateral wall of the vagina.

Locate and describe the bladder.

The *bladder* is a musculomembranous sac, situated in the pelvis behind the pubis and in front of the rectum in the male, and behind the pubis and in front of the cervix and upper part of the vagina in the female. It varies as to size and shape with age; in infancy it is conical, in the adult oval. The *summit* is connected to the anterior abdominal wall by the urachus and obliterated hypogastric arteries. The *body* is in relation inferiorly with the triangular ligament, symphysis pubis, and obturator internus muscle. The abdominal surface is covered by peritoneum; the *base* rests on the rectum in the male, the cervix and anterior vaginal wall in the female; the *neck* is constricted and continuous with the urethra. The neck is surrounded by the *prostate* in the male. The true *ligaments* are two anterior, two lateral, and a superior (urachus); the false are two posterior, two lateral, and a superior. The interior surface of the bladder is lined by mucous membrane; at the base is a triangular area with the apex at the urethra and the other angles at the orifices of the ureters (*trigonum*). *Structure:* The bladder consists of an external fibrous layer partially covered by peritoneum, a muscular layer (external and internal longitudinal, middle circular), submucous, and mucous layer.

Minutely describe the relations of the peritoneum to the bladder.

The superior surface of the empty bladder is covered by peritoneum, which leaves it along the lateral borders to reach the pelvic wall (lateral false ligament); in front it is reflected upon the urachus to reach the anterior abdominal wall (anterior false ligament); when empty this reflection lies below the symphysis pubis, when full it may reach a level 2 in. above the symphysis; posteriorly it is reflected upon the rectum in the male, the uterus in the female (posterior false ligaments); this reflection posteriorly does not alter to any extent during distention.

What portion of the bladder is uncovered by peritoneum?

The anterior wall, which is separated from the symphysis pubis by the prevesical space (cavum Retzii) and the base of the bladder.

Describe the male urethra and state its divisions.

The *male urethra* is a channel about 8 in. in length, leading from the bladder to the external urethral orifice at the extremity of the glans penis. The course of the urethra from the internal urethral orifice to the external meatus is S-shaped. It is customary to divide the urethra into the *prostatic*, *membranous*, and *spongy portions*. The first part of the urethra lies within the pelvic cavity and has an almost vertical course as it traverses the prostate. Turning forward, the urethra passes below the pubic arch and pierces the *triangular ligament*. Leaving the pelvic cavity, the urethra enters the bulb of the corpus spongiosum, where the latter is attached to the triangular ligament, and throughout the rest of its course it lies in the erectile tissue of the corpus spongiosum and glans penis. The common ejaculatory *ducts* and prostatic ducts open in the prostatic urethra; Cowper's glands into the bulb. Numerous minute glands (glandulæ urethrales) pour their secretion into the urethra.

Describe the female urethra as to (a) location, (b) dimensions, and (c) structure.

(a) The *female urethra*, after leaving the bladder, follows a slightly curved course downward and forward, below and behind the lower border of the symphysis pubis. As it leaves the pelvis, the urethra pierces the *triangular ligament*. The portion which lies between the deep and superficial layers of this ligament is surrounded by the fibers of the compressor urethræ muscle. It passes from the triangular ligament to the urethral orifice in the tissues below the symphysis and above the vagina.

(b) Excepting during the passage of urine the surfaces of the urethra are in apposition, the length is about 1½ in.

(c) The wall of the urethra is thick and contains much fibrous tissue; beneath this is found a *muscular layer* which is continuous with the bladder, and is composed of layers of inner circular and outer longitudinal smooth muscular fibers. Beneath this layer is the *vascular layer*, composed of blood-vessels and elastic fibers; this layer is lined by epithelium, transitional in the upper part and scaly in the lower. Numerous mucous glands open into the urethra.

Relate the differences between a virgin uterus and the uterus of a multipara.

The uterus of a multipara is larger, the cavity more marked, the arbor vitæ almost effaced, the external os is irregular or stellate instead of being a smoothly outlined slit. The cervix is smaller in proportion to the uterus than in the virgin.

Describe the broad ligaments of the uterus and their anatomic relations.

The *broad ligaments* are double folds of peritoneum extending from the sides of the uterus to the lateral walls of the pelvis, and with the uterus form a septum across the pelvis. They are reflected anteriorly upon the bladder, posteriorly upon the rectum. Between the two layers are found the Fallopian tubes, parovarium, uterine and ovarian arteries and veins, and lymphatics. The ovaries are attached to the posterior surface near the lateral wall of the pelvis.

Describe the Fallopian tubes and give their relations.

They are a pair of ducts which convey the ova from the Graafian follicle of the ovary to the uterus. They are about 4 in. long and are enclosed in a fold of peritoneum called the *mesosalpinx* (a portion of the broad ligament). Each tube consists of three portions—an *isthmus* or the portion which joins the uterus, an *ampulla* or middle portion, and an *infundibulum* or outer portion. The external opening is called the *abdominal ostium* and is surrounded by *fimbriæ*. *Structure:* The tube consists of an outer serous, middle muscular (external longitudinal, inner circular), and inner mucous coat which is continuous with the lining of the uterus.

Locate and describe the ovaries.

They are two flattened, ovoid bodies suspended by their anterior margins from the posterior surface of the broad ligaments, below the Fallopian

tubes. They are attached by their inner extremities to the uterus by the utero-ovarian ligaments; by their outer ends to one of the fimbriæ. *Structure:* An ovary consists of a number of *Graafian follicles* imbedded in the ovarian stroma. The ovary is covered by a serous layer derived from the peritoneum, but differs from that structure in consisting of columnar cells instead of endothelium. The stroma consists of connective-tissue with numerous spindle cells and abundant blood-vessels. The Graafian follicles are minute vesicles from $\frac{1}{100}$ in. in diameter to even $\frac{1}{20}$ in. after puberty; microscopically they have an external fibrovascular coat and an internal coat lined by a layer of nucleated cells, the *membranæ granulosa;* these cells are heaped up around the ovum at that part of the Graafian follicle nearest the ovarian surface to form the *discus proligerus.* The Graafian follicle contains a transparent albuminous fluid surrounding the ovum.

Describe the vagina.

The *vagina* is a cavity about 3 in. in length, open at its lower end, and communicating above with the cavity of the uterus. The cavity is directed downward and forward, describing a slight curve which is convex backward. The vagina is wider in the middle than at either end, and normally its anterior and posterior walls are in contact. In transverse section the lower part is usually an H-shaped cleft, the middle part a simple transverse slit, while the lumen of the upper portion, into which the *cervix* projects, is more open. As more of the posterior than of the anterior part of the cervix projects into the vagina, a deeper recess is formed between the posterior vaginal wall and the cervix than in front or laterally. The anterior vaginal wall is shorter than the posterior, the former being about 3 in. in length, the latter about 3½ in. At its lower end the vagina opens into the *urogenital cleft*, the opening being situated behind the orifice of the *urethra* and the *clitoris* and between the *labia minora.* The opening is partly closed in the virgin by a thin crescentic or annular fold called the *hymen*, torn fragments of which persist around the opening as the *carunculæ hymenales* after the fold has been ruptured.

What anatomic parts are involved in the descent of the testes?

In early fetal life the *testis* rests on the lower pole of the kidney and is connected with the inguinal region by the gubernaculum testis. A diverticulum of the peritoneum (*processus vaginalis*) works itself downward and inward through the internal ring, inguinal canal, and external ring, into the scrotum. The testis, with its mesorchium, passes through the canal posterior to the diverticulum, and reaches the *scrotum.* The diverticulum is gradually shut off from the peritoneal cavity.

What are the vesiculæ seminales?

They are a pair of hollow sacculated structures, about 2 in. in length, placed in front of the rectum and posterior to the bladder. They are really diverticula of the vasa deferentia, and consist of outer fibrous, intermediate muscular, and inner mucous layers. In function they are storehouses for the spermatozoa.

Name the component parts of the spermatic cord.

Vas deferens, cremasteric, spermatic, and vas deferens arteries; ilio-inguinal and genitocrural nerves, pampiniform plexus of veins, and lymphatics.

Describe the structure of the prostate gland and give its anatomic relations.

The *prostate* is enclosed in a fibrous *capsule*. The substance is reddish-gray and consists of *muscular* and *glandular* tissue. The muscular tissue consists of a circular layer immediately beneath the capsule and around the urethra; also scattered bundles through the gland. The glandular tissue consists of numerous follicular pouches opening by small excretory ducts into the prostatic urethra. The prostate is situated immediately in front of the neck of the bladder and surrounds the commencement of the urethra. It is in the pelvic cavity, behind and below the pubis, and posterior to the deep perineal fascia. The posterior surface rests upon the rectum.

Name in their order the structures between the cutaneous surface of the perineum and the mucous membrane of the bladder at the prostatic plain.

Skin, superficial fascia, inferior hemorrhoidal vessels and nerves, accelerator urinæ, transverse perinei muscle and artery, deep perineal fascia, levator ani, compressor urethræ, and membranous and prostatic portions of the urethra.

How is the eye supplied with blood?

By the ophthalmic artery, a branch of the internal carotid, which gives off the ciliary and arteria centralis retinæ branches.

Name the humors of the eyeball.

Aqueous and vitreous.

Describe the eyeball and give its parts.

The *eyeball* is almost spheric in shape; it is perforated by the optic and ciliary nerves and the ciliary and central artery of the retina. At the junction of the anterior and posterior segments the globe is pierced by the anterior ciliary artery. The eyeball is composed of two spheres, an anterior, transparent, *corneal segment*, and a posterior, opaque, *scleral portion*, the union of the two parts being indicated externally by a slight groove, the *sulcus scleræ*. The central points of the anterior and posterior curvatures constitute respectively the anterior and posterior poles. The sagittal and transverse diameters are nearly equal, usually about 24 mm.; the vertical diameter is about 23.5 mm. The eyeball consists of three concentric tunics, contained within which are three transparent refracting media. The three tunics are: (1) an outer fibrous coat, the *sclerocornea*, consisting of an opaque posterior part, the sclera, and a transparent anterior portion, the cornea; (2) an intermediate vascular, pigmented, and partly muscular tunic, the *tunica vasculosa oculi*, comprising from behind forward the *choroid*, the *ciliary body*, and the *iris;* (3) an internal nervous tunic, the *retina*. The three refracting media are named from before backward: the *aqueous humor*, the *crystalline lens*, and the *vitreous body*.

Describe each of the tunics of the eye and the different parts of each.

The *outer tunic* consists of the sclera and cornea. The *sclera* is a firm, opaque membrane, consisting of bundles of fibrous tissue closely interlaced. The sclera forms the posterior five-sixths of the outer tunic. It is pierced on the nasal side of the posterior pole by the optic nerve. At the equator are four openings for the exit of veins called venæ vorticosæ. The *cornea* is transparent, and consists of bundles of fibrous tissue enclosing corneal spaces in which are lodged corneal corpuscles. The cornea is richly supplied by sensory nerve fibers and is non-vascular. It consists, from before backward, of the following strata: (1) a layer of stratified epithelium; (2) an anterior elastic lamina; (3) the substantia propria; (4) a posterior elastic lamina; and (5) a layer of endothelium.

The *middle tunic* consists of the *choroid*, the *ciliary body*, and the *iris*. The *choroid* intervenes between the sclera and the retina, reaching as far forward as the ora serrata of the latter. The choroid is dark brown in color and is pierced posteriorly by the optic nerve. It is firmly attached to the sclera and thicker behind than in front. Its outer surface is flocculent and is connected to the sclera by the ciliary vessels and nerves and by the loose lamina fusca. Its inner surface is smooth and adheres to the outermost or pigmented layer of the retina. The *ciliary body* connects the choroid to the circumference of the iris and presents the following three zones: (a) *orbiculus ciliaris*, (b) *ciliary process*, and (c) the *ciliary muscle*. The *iris* forms a contractile diaphragm in front of the lens and is pierced a little to the nasal side of its center by an almost circular aperture, the *pupil*. The peripheral border of the iris is directly continuous with the ciliary body and through the medium of the ligamentum pectinatum iridis, with the posterior elastic lamina of the cornea.

The *retina* is the innermost tunic, and is made up of nerve-cells and fibers representing the expansion of the optic nerve. The layers from within outward are: (1) layer of nerve fibers; (2) layer of nerve-cells; (3) inner molecular; (4) inner nuclear; (5) outer molecular layer; (6) outer nuclear layer; (7) layer of rods and cones; and (8) layer of pigmented epithelium. The *macula lutea* is the point of most acute vision and is located to the temporal side of the optic disk. The retina is supplied by the *arteria centralis retinæ*, branch of the ophthalmic, and drained by the central vein of the retina into the ophthalmic vein.

What are the ciliary processes in the eye? Where are they placed, and what is their average number?

They are formed by the folding inward of the choroid at its anterior margin, and are received between the foldings of the suspensory ligament of the lens. They are attached to the ciliary muscle and arranged in a circle behind the iris. The average number is about seventy.

Describe the iris, giving its blood and nerve supply.

The *iris* is a thin, circular, perforated, contractile curtain, suspended behind the cornea and in front of the lens in the aqueous humor. It is the anterior portion of the middle ocular tunic and is formed of radiating and circular muscular fibers, nerves, veins, arteries, lymphatic spaces, and

fibrous stroma. Anteriorly, it is covered by a layer of polyhedral cells which are continuous with *Descemet's membrane.* The *pupil* is the opening in the iris and is placed slightly to the nasal side of the center. In the fetus the pupil is occluded by a membrane until about the eighth month. The *ligamentum pectinatum* is a reticular tissue connecting the iris and cornea. The *uvea*, a layer of purplish-hued pigment cells on the posterior surface, is continuous with the pigment layer of the *ciliary process.* The circular muscle contracts the pupil; the radiating fibers dilate it. The *arteries* are branches of the long and anterior ciliary. The *veins* empty into the ciliary process and anterior ciliary veins. The *nerves* are branches of the third, fifth, and sympathetic, through the long and short ciliary; third going to the sphincter (circular fibers), sympathetic to the sphincter (dilator fibers), and fifth, nerve of common sensation.

Describe the crystalline lens and state what tissues are in contact with it and how.

The *lens* is a transparent biconvex body, more convex posteriorly than anteriorly. It is enclosed in a *capsule* and consists of lens fibers derived from epithelial cells (ectoderm), arranged in layers, which are softer in consistency near the surface (*cortex*), and more compact at the center (*nucleus*). It is nonvascular in the adult; the hyaloid artery supplies it in the fetus. The lens is lodged in a depression in the vitreous where it is retained by the suspensory ligament attached to the ciliary body. The iris rests upon its anterior surface, the ciliary processes laterally.

Describe the lacrimal apparatus.

The *lacrimal gland*, which secretes the tears, is lodged in a depression at the outer and upper angle of the orbit; it pours the tears on the conjunctiva at the outer angle of the lids. The tears pass over the eyeball and enter the *puncta lachrymalia*, which are situated on the lacrimal papilla, on the inner end of the lids at the outer extremity of the *lacus lachrymalis;* from the puncta the tears pass through the superior and inferior canals to the *lacrimal sac.* The lacrimal sac is lodged in a deep groove formed by the lacrimal and superior maxillary bones. The sac empties into the *nasal duct*, which is a membranous canal about $\frac{3}{4}$ in. in length; it in turn empties into the *inferior meatus* of the nose. The opening into the nose is guarded by the valve of Hasner.

Describe he Eustachian tubes.

They are two tubes about $1\frac{1}{2}$ in. long, passing downward, forward, and inward from the middle ear to the nasopharynx. They consist of one-third bone and two-thirds fibrocartilage. They are lined by ciliated epithelium. The pharyngeal orifice is usually a vertical slit situated just above the floor of the nasal chamber, behind the posterior naris, and bounded posteriorly by a pad of cartilage.

Where may the Eustachian tube be entered and how may it be found?

The Eustachian tube may be entered from the nasopharynx; the *orifice* is placed at the upper lateral portion of the pharynx behind the posterior part of the inferior meatus, just above the level of the nasal floor.

Describe a hair-follicle.

The follicle is an *invagination of the epidermis* and corium which, in the case of large hairs, extends into the subcutaneous tissue. Each hair-follicle has a *duct of a sebaceous gland* opening into it. The portion of the follicle derived from the corium consists of a fibrous sheath of external longitudinal and internal circular connective-tissue fibers. The parts of the follicle derived from the epidermis are named the inner and outer root sheaths. The bottom of the hair-follicle is indented by a vascular papilla derived from the corium and capped by the *bulb* or expanded part of the hair root.

HYGIENE

Define hygiene.

Hygiene is the science of the preservation of health and prevention of disease.

Define humidity of the atmosphere. Why should a humid atmosphere cause rheumatic persons and persons suffering with gout increased sensitiveness?

Humidity is the amount of vapor of water in the air. Increased humidity increases the sensitiveness of gouty and rheumatic patients by diminishing the elimination through the skin of organic matters and uric-acid derivatives, which results in retention of these poisons in the system.

Describe the effect of a hot and moist climate on the human system, and state the class of diseases this atmosphere is likely to induce.

Inhabitants of hot, moist climates are of small stature, deficient muscular development, nervous temperament, and languid disposition. The most prevalent diseases are malaria, yellow fever, cholera, and affections of the liver and gastro-intestinal tract.

How do forests benefit public health?

They afford protection against winds, increase the quantity of oxygen and ozone, especially pine forests, in which the aromatic substances given off may also possess an antiseptic influence and absorb carbon dioxid. Their general effect is tonic and stimulating. The difference between the day and the night temperature is less marked.

What conditions of ill-health make residence in high altitudes dangerous? Why?

Affections of the heart, kidneys, and lungs, especially the late stages of consumption; emphysema and arteriosclerosis (old age). The rarefied condition of the air causes increased respiratory and cardiac action.

What localities should be sought or avoided by rheumatic patients?

A warm, dry, equable climate is most suitable. Dryness of the air is more important than the absence of cold. Localities with alkaline or sulfur hot springs are desirable.

Dampness, valleys shut in on all sides, the vicinity of large rivers and the seacoast, and all localities exposed to high winds and sudden changes of temperature should be avoided.

Mention six desirable factors in the location of a resort for consumptives.

An equable climate, moderate altitude, a dry atmosphere, pure air, abundant sunshine, and pure water.

Give a fair average death-rate (a) in rural districts, (b) in towns of from 5000 to 20,000, and (c) in cities of over 100,000 inhabitants.

(a) 14, (b) 17, (c) 21 per 1000.

State the ordinary death-rate of each of four cities having, respectively, a population of more than 50,000.

Berlin, 17; Amsterdam, 17.8; Dublin, 39.9; St. Petersburg, 31 per 1000.

Why and how is carbon dioxid deleterious to health?

In itself it is not injurious in ordinary proportions, from 0.03 per cent. in pure open air to 0.6 or even 1.0 per cent. in closed rooms. Carbon dioxid is an indicator of the quantity of organic impurities present in the air. A larger proportion of artificially prepared carbon dioxid can be tolerated than of carbon dioxid resulting from animal respiration.

How much fresh air is required by an adult for normal respiration during twenty-four hours?

3000 cubic feet per hour, or 72,000 cubic feet in twenty-four hours.

What deleterious gases accumulate in improperly ventilated sleeping-rooms?

Carbon monoxid, carbon dioxid, hydrogen sulfid, and ammonium sulfid.

What are the necessary hygienic conditions of a model sleeping-room?

The height of the apartment should be nine feet, the floor space sixteen square yards. Twenty-five cubic yards of air space must be allowed for each occupant. The temperature in winter should not be above 68° F. The room must have at least one window, equal in area to at least one-tenth of the floor space, and opening half its size. Metal bedsteads are to be preferred, furnishings should be few and simple, and all dust-collecting hangings should be banished from the room. The cleansing of the room must be systematic and thorough. The ideal method is the "vacuum," which is now employed in the most modern hospitals.

What is the proper temperature for a living-room in winter?

68° to 70° Fahrenheit.

State the results to animal life of the combustion of fuel in a room without chimney connection or other ventilation.

Carbon monoxid poisoning and asphyxiation, due to excess of carbon dioxid and lack of oxygen.

Describe a simple method of ventilating the sick-room.

In winter place a wooden strip, three inches wide and as long as the window-frame is wide, under the lower sash; through the space between

the top of the lower and the bottom of the upper sash, enough air will enter the room. In summer open the windows from the top. Be careful that the patient is protected from drafts.

What are the methods of ventilating dwellings? What sanitary principles are involved?

Methods of ventilation vary with the size and character of the building to be ventilated, the number of occupants, the exposure, the necessity for artificial heating, and similar factors. They may be divided into natural and artificial. In *natural* ventilation the diffusion of gases and the movements of the air caused by wind, and especially by inequalities of temperature, are utilized. *Artificial* ventilation is effected by the employment of apparatus to displace vitiated air by fresh air, either through the action of heat or by mechanical means such as pumps (forced ventilation), jets, fans, bellows, and the like (propulsion).

Give an opinion as to the sanitary effect of the different methods of heating houses.

The *hot-water system* is the best, but it is expensive and a skilled man is required to look after it. It does not furnish warm, moist air, as is generally supposed, and the temperature can easily be regulated. No injurious products of combustion escape into the room and, when indirect radiation is employed, no artificial ventilation is required. Radiation is called *direct* when the steam or hot-water radiators are placed inside the room; *indirect* when they are entirely outside, the heated air entering through flues. When the radiators are partly inside and partly outside, the room is said to be heated by *direct-indirect* radiation.

Next in value, from a sanitary standpoint, is *steam heating* by direct or indirect radiation. The disadvantage is the difficulty of regulating the degree of heat.

Open fire-places are very good ventilators, but yield an unequal and insufficient supply of heat; they also cause drafts in cold weather.

Hot-air furnaces and *stoves* are efficient if the air supply can be kept pure. Ventilation is necessary, however, and gases will leak from the fire-box into the hot-air chamber.

What effect have ground air and water on the health?

Ground air is always impure from contamination with bacteria, carbon dioxid, and other deleterious gases. It causes a decrease of vitality and is a means of spreading disease.

Ground water from near the surface of polluted soils contains numerous bacteria and products of decomposition. It predisposes to catarrhal and rheumatic affections and contains the germs of infectious diseases.

In the selection of a site for a dwelling what is the best soil, subsoil, and topography?

A light, dry soil with a nearly constant level of ground water. Both the soil and the subsoil should be free from clay and other impermeable material. Low-lying ground and any locality where water collects should be avoided in the selection of a building site. The side of a hill, with a southern or southeastern exposure, is preferable to the top of an elevation.

Mention the danger of excessive shade about dwellings.

It interferes with the free movement of air, prevents the entrance of the sun's rays, diminishes evaporation, and keeps the dwelling damp.

Give some of the requisites for the sanitary construction of house foundations and cellars.

If the surrounding soil is damp, the foundation walls should be sunk to a sufficient depth to prevent leakage into the cellar from below in times of heavy rain. The walls below the level of the ground and the inside of the cellar, as well as the floor, should be of cement. Enough windows must be provided to insure fresh air and sunshine.

Discuss detached wards versus many-storied buildings for a public hospital.

General supervision and the maintenance of discipline are easier in hospitals consisting of one large building. Other advantages are ease of communication, more prompt service, and greater economy of administration. On the other hand, the isolation of suspected or contagious cases is more difficult (the roof can be utilized for an isolation ward, as in some modern hospitals), the supply of sunlight is less, and the danger in case of fire greater.

Give the special hygiene of factories in which women and children are employed.

Sufficient air space must be allowed for each person employed to insure a supply of from 60 to 100 cubic meters of fresh air per hour. Thus, if the ventilation is such that the air is renewed three times in an hour, the amount of air space per individual must be from 20 to 35 cubic meters. Suitable ventilators that will carry off dust as well as vitiated air and injurious gases must be installed. The temperature should be about 65° Fahrenheit. Ample and properly constructed wash-rooms and water-closets with modern plumbing must be provided.

Describe efficient methods for securing sanitary conditions of street railway cars.

The cars should be ventilated from above by means of ventilators in the top that can be turned in such a way as to prevent the entrance of dust while the car is in motion. Cane seats, which can be washed or wiped clean and do not harbor dust, are much preferable to upholstery, which should be abolished altogether. The construction and finishing work should be such as to permit thorough brushing or washing, and this should be done at least once a day. Spitting on the floor of the car should be prohibited.

What measures, including diet and medication, should be used on shipboard or in camp to eradicate scurvy?

The diet must contain some fruit and vegetables, and salt foods should be reduced to a minimum. The men must be made to bathe frequently, and on shipboard spend some time on deck every day. Medicinally, lemon-juice, vinegar, and tonics, with a potassium chlorate mouth wash, are indicated.

Outline the construction of a camp hospital, especially providing for the care, with least danger to other patients, medical and surgical, of those suffering from contagious diseases.

Select a dry, if possible, sandy soil, or at least one without much clay, on elevated ground to insure drainage, preferably a hillside with a southern exposure. For a summer hospital a few shade trees in the vicinity are desirable. The *pavilion plan* is the best, whether frame buildings or tents are used. The arrangement of the buildings must be such as to facilitate administration and the maintenance of strict discipline. About 50 cubic meters of air space must be allowed for each patient, the air being renewed about three times every hour, and the windows and other openings so disposed as to provide a maximum of air and sunshine with a minimum of exposure. One building is reserved for contagious cases, another for the temporary isolation of suspected cases, and, if possible, a separate ward for contagious surgical diseases. If the water supply is not above suspicion, the drinking water must be boiled. The strictest discipline must be maintained; convalescents from typhoid fever and dysentery must not be allowed to help in the preparation of the food. If the locality is malarial, the openings in the buildings must be screened, and in any case this is desirable in order to protect the patients themselves and the food from flies. The privies require attention. A trench is dug, the privy placed over it, and the discharges are kept covered with earth. As soon as the trench is full another is dug, and the privy is moved over that. Garbage and soiled dressings, as well as all infective material, are disposed of by burning.

What constitutes hard water and soft water?

Hardness is the capacity water has to dissolve soap, and depends on the amount of magnesium and calcium salts in solution. Soft water contains little or no dissolved salts and rapidly forms a lather with soap.

What conditions are essential to a good water supply?

Purity at the source and adequate subsequent protection against contamination; constancy of supply and practicability of artificially increasing it if necessary, and opportunity for storing. The water should not be too hard. Hard water cakes the boilers in manufacturing plants, and this may cause explosions.

What is the temperature of tepid water? Of hot water? Of boiling water?

Tepid water, 80° to 90° F.; hot water, 100° to 110°; boiling water, 212°.

What are the chief sources of contamination of drinking-water?

Sewage emptied into the stream from which the supply is obtained; surface water in settled districts gaining entrance to the supply; subsoil water, after passing through infected soil; drainage from cemeteries and from soil containing mineral poisons; lead pipes.

Describe the several methods of purifying drinking water.

Sedimentation, allowing the water to remain at rest for a time, is used in connection with other methods. The suspended matter at least is removed, and the water is cleared.

The best *filters* for domestic use are Pasteur's and Berkefeld's. Other filters are made of stone, unglazed porcelain, or charcoal, need frequent cleansing, and act merely as mechanical strainers. Water that has passed through the ordinary filter must be boiled if pathogenic bacteria are to be removed.

Sand Filtration.—The water is made to flow through prepared beds of sand and broken stone. The action is both mechanical, removing the suspended matter, and chemical, as oxidation of organic matter and bacteria goes on in the superficial layer (*felt top*). As the natural pellicle is soft, certain substances, such as alum and iron (scrap iron), are added to harden the filter and increase its resistance to pressure. A properly constructed sand filter should allow not more than 300 germs in a centimeter and no organic matter to pass through.

If a chemical analysis of water revealed the presence of nitrites and nitrates, would this condemn it for drinking purposes? If so, why?

Yes, especially if nitrates are present. Organic matter, particularly sewage, is converted first into nitrites and then into nitrates by the action of bacteria; hence the presence of these substances indicates the previous pollution of the water.

Name three tests for detecting impurities in water.

Nessler's test for detecting and estimating the amount of ammonia, the nitrate of barium test for sulfates, and the nitrate of silver test for chlorids.

What diseases are propagated by drinking water? How can their spread be prevented?

Typhoid fever, cholera, and dysentery; diseases due to animal parasites (except malaria) and to mineral poisons (lead). Their spread can be prevented by prohibiting the use of unfiltered or unboiled water and of water containing mineral poisons in solution.

What are some of the dangers involved in the domestic use of ice?

Ice may contain pathogenic bacteria and ammonia.

Give the prophylaxis of the filth diseases.

Sanitary inspection of all houses and other buildings, with immediate abatement of any nuisance discovered. Examination of the water and food supply. Thorough inspection of closets, sewers, and the disposal of garbage and other waste. Isolation of patients and disinfection of dwellings and personal property of such patients. The establishment of house, municipal, state, or national quarantine. Protection against flies and other insects.

What are the sanitary requirements of house plumbing?

Each house must be connected directly by pipe with the common sewer. The piping in the house must be of iron, with screwed couplings, and in plain view. The drainage-pipe should have a drop of 1 in. in every 4 ft., and should be provided with a trap, placed beyond all inside connections. The water-closets, bath-tubs, wash-bowls, and sinks must have tight joints and must also be provided with traps and trap ventilators. Soil-pipes must have ventilators extending at least 2 ft. above the roof.

What is the best means of preventing the access of sewer gas to dwellings?

Place a trap or water-seal between the house drain and the sewer, and provide an air inlet pipe into the drain between the trap and the house. The ventilator pipe should extend from the house drain at least 2 ft. above the roof.

Mention some of the objections to storage cisterns under ground. What are the objections to rain water as a drink?

Storage cisterns are usually dirty, difficult to clean, and cannot be properly ventilated. The water in the cistern may be contaminated when the overflow pipe is connected with the drain or soil-pipe of a house.

Rain water is insipid; the first part collected contains dust, pollen, and other matters derived from the air. The supply cannot be regulated.

Define the word "nuisance" in a broad hygienic sense.

Anything that actually injures, or is likely to injure health, and admits of a remedy either by the individual whose act or omission causes the nuisance or by the local authorities.

Name some of the nuisances dangerous to health.

Gases and dust of an offensive, irritating, or poisonous nature emanating from industrial establishments or refuse. Smoke from factories and railroads. Collections of stagnant water, garbage, and animal matter exposed to the air. Industries that give rise to great noise or vibration in thickly settled communities.

How may a privy in the city or country be kept from becoming a nuisance while in use?

A disinfectant and deodorant substance, such as chlorid of lime, should be poured into the privy vault every few days, and the vault emptied at short intervals. Ventilation must be secured by means of a pipe extending from the vault to the top of the privy.

Mention some of the objections to curbed or driven wells in streets or houses, with respect to the purity of water coming from these wells.

The curbing rarely affords adequate protection to the well-water against contamination from sewers and gas-pipes. In driven, piped wells the water is taken from far below the surface, and in city streets the soil is so contaminated with noxious material that the water is in danger of pollution.

What is the most sanitary way of disposing of city garbage?

Incineration.

What is the best sanitary plan for the disposal of sewage?

Collect the sewage in large tanks and add lime to it. Compress the solid material after its precipitation and incinerate. Allow the liquid sewage to flow upon specially prepared filter beds, which are subdrained; the water coming from these drains may then be allowed to flow into a stream without great danger of contamination.

What is the best sanitary disposition of stable manure in large cities?

The liquid portion of the manure should be carried off into the general sewer by properly constructed drains running along the rear of the stalls. The solid, dried manure and straw may be kept in well-covered pits, from which they must be removed at short intervals in covered wagons and conveyed to the country to be used as fertilizer.

State the advantages of cremation over earth burial.

The danger of contaminating the water supply in the vicinity of cemeteries is obviated, as all disease germs are completely destroyed.

What injurious influences, if any, do cemeteries exert on the health of persons living in their vicinity?

The water coming from a cemetery, if the soil is rocky and clefts run from a grave to a well or other water supply, may become contaminated. Constant turning of the soil may set free the bacteria of infectious diseases, although experiments have shown that pathogenic germs are killed in a short time by the action of putrefactive bacteria. Cemeteries situated in a suitable locality where the soil is of the best, if properly managed, are not a source of danger to the community.

What care should be employed in exhumations?

The exhumation of those dead of a contagious disease should be forbidden. Whenever possible, exhumation should be done in cold weather; the presence of all persons except those absolutely needed should be forbidden, and the coffin should not be opened, but placed at once in a zinc-lined box and sealed.

State the average weight of feces in twenty-four hours in a normal man. What proportion is made of liquid, and what of solid contents?

From 6 to 8 oz., of which 75 per cent. is liquid.

What do you understand by the "dry earth system" as applied to excrementitious matter?

The discharges are received in a box containing dry earth, and, after using the privy, fresh earth is added from a "hopper." The receptacle is emptied from time to time, and fresh earth placed in it.

What is sewer gas? How does the inhalation of sewer gas in large quantities affect the system?

Sewer gas is a mixture of a number of gases—carbon monoxid, also carbon dioxid, ammonium, and hydrogen sulphid—resulting from the decomposition of animal and vegetable matter. In itself, sewer gas does not cause disease, but if it is present in the air in sufficient quantities it acts injuriously by the deprivation of oxygen, causing anemia and other conditions due to deficient oxygenation.

The excavation of streets in cities is frequently followed by the outbreak of diseases, such as diphtheria and typhoid fever. What is the cause?

When the ground is broken and the soil exposed to the air, the contained pathogenic bacteria are set free by the drying out of the soil and scattered by the wind, or gain entrance to the food or water supply and cause disease in susceptible individuals.

What hygienic precautions are necessary to insure healthy sleep?

Adequate ventilation and a room temperature of about 60° F.; absence of light and freedom from noise; clean bed-linen and blankets sufficient to keep the sleeper warm without overheating. The head may be elevated by resting on one pillow. Feather beds should be avoided.

What are the respective merits of cotton, wool, and silk, when used for underwear?

In variable weather *wool* is preferable, because it is a non-conductor of heat and hygroscopic; woolen underwear thus tends to retain the body-heat by absorbing the moisture of sudation, prevents evaporation, and sudden chilling of the body. For this reason, woolen underwear is the best in a variable climate and wherever the difference between day and night temperature is very great. Next to wool, *silk* is the best non-conductor, and the softness of its texture recommends it to those who can afford the relatively high cost. In a warm, equable climate *cotton* underwear, which retains the heat less than wool and silk, and has the advantage of cheapness, is quite satisfactory.

What hygienic means should be employed by persons prone to "catch cold?"

A cold shower, sponge, or full bath in the morning immediately after rising, followed by brisk rubbing with a coarse towel; free ventilation in the bedroom; avoidance of mufflers, ear-tabs, and the like contrivances. Part of each day should be spent in the open air.

What method would you suggest for the hygienic care of the skin?

Daily exercise in the open air; plenty of sleep; liberal ingestion of water; a cold sponge or shower on arising, followed by a brisk rub; an occasional hot bath, to which an alkaline salt (bicarbonate of soda) may be added.

State the value of public baths to the health of a large city.

Besides giving those who desire it an opportunity to keep clean, they encourage cleanliness among the inhabitants, generally, and thus serve to prevent or at least diminish filth diseases.

What are the hygienic requirements and physiologic effects of bathing?

The bath should be taken on arising, or not less than two hours after a meal. A cold bath, taken for its tonic effect, should be of a temperature of about 65 degrees F., and the duration about five minutes. The surface of the body should be rubbed briskly with the hands or bathing mitts, and afterward thoroughly dried with a rough towel until a good reaction, shown by redness of the skin, is obtained. The effects following a bath are the removal of dirt and dead epithelium, stimulation of the function of the skin, increased activity of the circulatory and respiratory organs, and a general tonic effect on the nervous system and on metabolism.

What physical conditions would render the taking of a Turkish bath inadmissible?

General arteriosclerosis; diseases of the heart and lungs.

Mention some of the diseases to which artisans are especially liable.

Lead, arsenic, copper, and phosphorus poisoning; pulmonary and bronchial affections from the inhalation of coal dust and other kinds of dust (miners, glass-blowers, etc.); emphysema from constant, excessive distention of the lungs (cornet players, glass-blowers).

In the pursuit of what trades is there a predisposition to pulmonary diseases?

All those trades which have to be carried on in ill-ventilated and over-crowded rooms or in damp quarters (sweat-shops, etc.); those which are attended with the production of dust and of noxious gases; glass-blowing.

Mention the effects of working in phosphorus, as in the manufacture of phosphorus matches. How can the dangers be limited or obviated?

Phosphorus fumes produce necrosis of the inferior and superior maxillæ, particularly in persons with carious teeth. The danger arising from this source may be minimized by careful attention to the condition of the teeth and the systematic use of a mouth wash consisting of lime-water and sodium bicarbonate, as well as cleanliness of the body generally, particularly the face and hands. The factory should be provided with forced ventilation, so that the fumes are carried off as fast as they are produced.

Is green wall-paper objectionable? If so, why?

Yes. In cheap wall-paper the color is frequently made of a compound of copper and arsenic. The alternate action of dampness and heat disintegrates the surface of the paper, the particles are rubbed or blown from the walls and fill the air, giving rise to acute or chronic arsenic poisoning.

Name four diseases that are communicable to man through cows' milk.

Typhoid fever, tuberculosis, diphtheria, and scarlet fever.

What are the principal adulterations of milk?

Addition of water and removal of cream; addition of coloring matter, preservatives (boric acid, salicylic acid, formalin), and gelatin for thickening.

How may milk be the means of transmitting the germs of typhoid fever?

The contamination usually results from the use of infected water in washing the milk cans and bottles, or from failure to sterilize bottles that have been contaminated by contact with a typhoid patient; rarely from direct addition of infective water.

Mention some of the advantages of carefully prepared artificial ice as compared with natural ice.

If the proper precautions are observed in its manufacture, artificial ice is free from bacteria and inorganic impurities (lead, iron, etc.). The cakes may be frozen in any desired size and shape. Artificial ice plants can be established anywhere—in hospitals and other institutions—thus insuring a constant supply of ice without dependence on local ice companies.

Does change in climate require any change in food? If so, what?

Yes. In cold climates the organism requires more animal food (meat and especially fat) in order to maintain the body heat. In hot climates a diet consisting chiefly of vegetables and fruit is more suitable. Fermented and distilled liquors should be avoided by those living in tropical countries.

Describe the agency of the ptomains in inducing diseases, and the disorders produced by them.

Ptomains are poisonous bodies produced during the decomposition of nitrogenous substances. They are derived from partially decomposed animal food, especially canned meats, and when absorbed in the body give rise to a condition known as *ptomain poisoning*, characterized by headache, fever, nausea, vomiting and diarrhea, torpor, and at times a fatal termination.

Describe the transmission of diseases by meat and fish.

Diseases resulting from the eating of meat and fish may be due to (1) ptomains or inorganic poisons, (2) vegetable parasites (bacteria), (3) animal parasites (worms or their larvæ or ova) contained in the food.

Bacteria and animal parasites are destroyed by thorough cooking; poisons are not. 'Measly' beef may contain the bladder-worm (*Cysticercus bovis*), the larva of *Tænia mediocanellata*, or beef tapeworm, which develops into the adult worm in the human intestine. Beef is the *intermediate*, man the *definitive* host. In a similar manner *Tænia solium* may result from the eating of improperly cooked or insufficiently salted pork. Pork

contains the larvæ of *Trichinella spiralis*, and when eaten raw, especially in the form of sausage and Westphalia ham, or insufficiently cooked, may give rise to the disease known as *trichiniasis*. The larvæ enter the intestinal tract with the food; there they develop into adult worms, which in turn produce numbers of the larval worms and die. The larvæ make their way into the muscles and become encysted, producing trichiniasis.

The larvæ of *Bothriocephalus latus*, or the fish tapeworm, are contained in a number of fresh water fish, especially pike, turbot, perch, etc., and when the flesh or roe of these fish is eaten raw or imperfectly cooked the larvæ may enter the alimentary canal of man. The disease is rare in this country.

What conditions and diseases in animals render their flesh unfit for food?

The flesh of all animals that have died of any constitutional or infectious disease or of overdriving, or which have been slaughtered while suffering from such disease, is unfit for food. Animals that have been poisoned, died of starvation, and animals that have not been bled when slaughtered, should be condemned, as well as all meat containing trichinæ or other animal parasites capable of producing disease in man. The latter may be determined by microscopic inspection.

What is the Trichina spiralis? Describe the effects of Trichina spiralis on the human system.

Trichina spiralis is an animal parasite which in its adult stage infests the intestinal tract of man and a number of mammals, especially *hogs*, rats, and mice. The trichinæ enter the alimentary canal of man in larval form, encysted in infected, insufficiently cooked, or raw ham or sausage. The capsules are digested and the larvæ set free in the small intestine, where they develop into mature worms in about three days. The male worms die after fertilization, while the females ahdere to the mucous membrane or perforate the intestinal wall and get into the mesentery or its lymphatic glands. Each female gives birth to large numbers of larvæ during its life, which is about seven weeks. The successive broods of larvæ are carried away from the bowel or mesentery by the lymph-stream and lodge in the striated muscles. The *symptoms* are intense irritation, fever, and muscular pain, which may be extreme, especially during motion. Diarrhea may be present. While recovery is the rule, many cases prove fatal, death taking place from exhaustion and anemia. *Eosinophilia* is present, and the encysted trichinæ may be demonstrated in excised pieces of muscle.

What constitutes a thorough meat inspection?

Meat should be inspected within twenty-four hours after the animal has been killed. The following points are important: the quantity and character of the fat, its color and consistency; the condition of the flesh and bone-marrow; and signs of infectious disease in the lungs, liver, or kidneys. The flesh should be examined under the microscope for the presence of pathogenic bacteria, trichinæ, or bladder-worms (the larval forms of tapeworms). When possible, it is advisable to investigate the methods employed in storage and refrigeration.

How should an inspection of milk be conducted?

The points for determination are: specific gravity, color, percentage of cream, presence or absence of preservatives, diluents, or coloring matter; quantity of total solids; quality and quantity of ash, fats, casein, and lactose. A bacteriologic examination should be made and the number and variety of bacteria noted. Finally, the source of supply and the methods of storing and distributing the product should be subjected to careful scrutiny.

Mention some of the adulterations in the preparation of ground coffee for sale in the shops.

Chicory, peas, beans, roasted cereals, acorns, and sawdust.

What precautions as to food and drink should be observed by those forced to work under the direct rays of the sun in summer weather?

The diet should be light and consist chiefly of vegetable food. Meats and all heavy articles of food should be avoided until the day's work is done. Water and other non-alcoholic beverages may be taken freely; malt and distilled liquors must be avoided.

What is understood by the germ theory of disease? Mention all diseases whose causes are known to be micro-organisms.

According to the germ theory, the exciting cause of every infectious and contagious disease is a micro-organism, and such diseases are communicated only by the invasion of the particular germ and its development in or upon the tissues of the infected individual.

The diseases due to specific micro-organisms are: tuberculosis, pneumonia, influenza, typhoid fever, typhus fever, relapsing fever, epidemic cerebrospinal meningitis, cholera, dysentery, diphtheria, tetanus, erysipelas, gonorrhea, and probably syphilis, leprosy, anthrax, and glanders.

Differentiate between endemic and epidemic diseases.

An endemic disease is one which is more or less constantly present in a certain district or locality. An epidemic disease is one which appears suddenly and attacks many persons at the same time.

(a) To what diseases are negroes comparatively insusceptible? (b) In the Middle States to what diseases are negroes more prone than whites?

(*a*) Yellow fever, dysentery, and diseases resulting from great heat.

(*b*) Small-pox, respiratory diseases, fibroid tumors, keloid, syphilis, and tuberculosis in all its forms.

Mention five preventable diseases.

Small-pox, yellow fever, typhoid fever, pulmonary tuberculosis, cholera, and malaria.

Name and describe the methods of transmission of the most important infectious and contagious diseases.

The specific micro-organisms may gain entrance to the body (1) through the *respiratory system*, as in pulmonary tuberculosis, pneumonia, influenza, and diphtheria; (2) through the *alimentary tract*, as in typhoid fever, dysentery, and cholera; (3) *by contact*, as in small-pox and the acute eruptive fevers (probably), in gonorrhea and syphilis, and in leprosy; (4) *by inoculation*, the micro-organism entering the blood, as in malaria, erysipelas (probably), and tetanus.

Diseases due to the invasion of the intestinal tract by the specific micro-organism are usually caused by drinking infected water or milk, or by eating uncooked food, such as salads and fruit, oysters, etc., contaminated with infected water. Contagious diseases may be acquired by direct contact with the patient or indirectly by contact with clothing or other fomites infected with the germs.

What are the principal measures which you would employ for the prevention of the spread of infectious diseases?

Disinfection of all discharges and everything that has come in direct contact with the patient. Soiled linen should be disinfected before being washed. The patient should have separate eating utensils. In the case of contagious diseases *isolation* of the patient and nurse, who must not leave the sick-room without first cleansing hands and face with an antiseptic solution and removing the clothing worn while attending the patient. In the case of small-pox strict isolation of both patient and nurse and quarantine of the entire household are necessary. To prevent the spread of a water-borne disease all persons should be enjoined to drink only boiled water.

What precautions should a physician observe to avoid carrying contagious diseases?

Before entering the sick-room the physician should put on a gown or linen duster long enough to cover the entire body; the trousers may be turned up and the hair protected with a cap, leaving only the face, the hands, and the feet uncovered. Rubber gloves may be worn. In examining the patient contact of any part of the body except the hands with the patient or bed-clothes must be avoided. Immediately after leaving the sick-room, wash the face and hands thoroughly with soap and water and disinfect in carbolic acid or bichlorid solution; then remove cap and gown. The nurse should be instructed to saturate cap and gown with bichlorid solution once a day.

What is the value of preventive inoculation in cholera and diphtheria?

In diphtheria the injection of antitoxin is both curative and prophylactic. In cholera there is apparent benefit without he production of absolute immunity.

What are the most common sources of infection in diphtheria?

Direct contact with the sputum or shreds of membrane coughed up by a diphtheritic patient; contact with fomites: clothing, books, drinking-cups, and the like.

What hygienic precautions should be employed about diphtheria?

Isolation of patient until convalescence is completed, as shown by two negative cultures from the affected area. Only those whose presence is absolutely necessary must be allowed to enter the sick-room, and they must wear gowns and caps (as explained on page 253). The patient's excretions must be disinfected and dressings, if there are any, burned. The members of the household should be quarantined, and should receive a prophylactic injection of antitoxin. After the patient has recovered the sick-room and contents are disinfected.

How long does a diphtheria patient remain infective? How may it be proved that this infective period has ceased?

From two to three weeks after the disappearance of local symptoms. When two successive cultures from the affected area, made on different days, fail to show the specific bacteria, the patient is no longer a source of infection.

Can it be proved that the diminished death-rate from diphtheria so generally announced is due to the use of diphtheria antitoxin? Give reasons.

Yes. By comparing the death-rate in two wards of the same hospital, in one of which diphtheria antitoxin is used while it is withheld in the other, the death-rate is found to be much lower in the former.

Describe the hygienic care of a patient and his surroundings in scarlatina.

The patient and his nurse must be isolated, as in the case of diphtheria (see above). Soiled linen should be disinfected with carbolic acid or bichlorid solution before being removed from the room; if convenient, it may be boiled. As soon as desquamation begins, the skin should be anointed with carbolized vaselin in order to prevent dissemination of the contagium by the cast-off scales. Before the patient is discharged and the quarantine raised, both patient and nurse must take warm baths and put on clothing that has not been exposed to the infection. The sick-room and all its contents must be disinfected.

State the period of incubation in (a) vaccinia, (b) parotitis, (c) pertussis, (d) varicella, and (e) rotheln.

(a) Three to seven days; (b) fourteen to twenty-one days; (c) seven to ten days; (d) ten to fifteen days; (e) ten to twelve days.

Contrast the incubative stages of variola and measles.

The incubative stage of variola is from eight to fourteen days; that of measles from seven to eighteen days.

Contrast the incubative stages of measles and scarlet fever.

Measles, seven to eighteen days; scarlet fever, one to seven days.

What explanation can be furnished for the greater prevalence of diphtheria and small-pox in cold than in warm weather?

During cold weather ventilation is imperfect; the poorer classes, especially, spend less time out of doors; rooms are frequently overcrowded; and less attention is paid to personal cleanliness.

Describe the most approved method of performing vaccination and relate the complications that may occur as results of faulty methods.

The arm is cleansed with soap and water in the region of the insertion of the deltoid muscle; but no antiseptic, not even alcohol, is to be used. An area about ¼ in. square is scarified with a needle, previously passed through a flame to sterilize, or with a sharp knife, until serum appears in small droplets. The scarification must not be carried to the point of drawing red blood. Glycerinated virus is then applied from a tube or ivory point and rubbed in for a few seconds. When the vaccine has become dry, which requires from ten to fifteen minutes, the vaccinated area should be covered with a shield held in place with adhesive strips. The shield may be worn until inflammatory reaction begins, after which it must be removed and the vaccinated area properly dressed and treated like any infected wound. Neglect of these precautions may result in secondary infection of the wound with staphylococci, streptococci, tetanus bacilli, or other bacteria. The greatest danger is from tetanus and pus infection.

What is your view concerning the propriety or necessity of inserting vaccine virus in multiple places?

It is unnecessary and unwise. One successful vaccination suffices to protect against small-pox; multiple vaccinations multiply the chances of infection; the resulting scars add to the disfigurement of the member and confuse the record of vaccination.

State the objections usually advanced against vaccination as a preventive of small-pox.

It is stated that vaccination fails to protect against small-pox, that it may cause blood-poisoning, and that there is danger of transmitting diseases, such as syphilis and tetanus. The latter, especially, it is objected, may have been present in the horse from which the virus is obtained.

Which, in your judgment, is to be preferred in vaccination, animal or humanized lymph, and why?

Animal lymph; because greater care to insure freedom from bacteria is possible, and because the supply can be more readily controlled. Syphilis cannot be transmitted by animal lymph.

State the accepted belief in respect to the limitation of protection from vaccination.

The period of protection is generally believed to last about seven years, at the expiration of which revaccination should be tried. During a small-pox epidemic it is advisable to revaccinate all persons who have not been vaccinated within three years.

Describe in detail the sanitary precautions necessary in typhoid fever.

The stools, urine, vomit, and sputum should be disinfected with a solution of chlorinated lime (6 oz. to a gallon of water). Towels, napkins, bed-linen, and all clothing used by the patient must be disinfected with a 5 per cent. solution of carbolic acid or 1 to 1000 bichlorid solution before removal to the laundry. The nurse must be careful to wash and disinfect the hands each time after attending to the patient's wants. Fumigation is advisable after the patient has been removed from the sick-room.

Through what media is the typhoid poison usually communicated?

Drinking-water; also milk, oysters, and green vegetables that are eaten raw. In each case it is the water in contact with these foods that contains the bacteria.

What is the best method of disposing of the bodies of those who have died of yellow fever?

Cremation.

What hygienic measures should be observed in the management of croupous pneumonia?

It is usually not considered necessary to isolate a pneumonia patient. The sputa should be collected in paper spit-cups or on material that can be burned. The bed and clothing should be disinfected after the patient is well.

What is bubonic plague? What steps can be taken to limit or extinguish such a scourge?

An acute, infectious, specific disease, characterized by inflammation and, in many cases, suppuration of the lymph-glands, especially in the groin (hence the name). An organism discovered by Yersin is found in the glands and in the blood.

Prevention depends upon isolation, thorough disinfection of the premises where a case is discovered, or, if necessary, quarantine of the entire town or district. As the disease is known to be transmitted by rats, these rodents should be exterminated in times of epidemic.

Describe in full the causes of malaria and its prevention.

The cause of malaria is an animal parasite, commonly called *Plasmodium malariæ*, although, since it is not found in the plasma, but in the corpuscles, it should be properly called a hemameba. The *intermediate host* of this parasite is the mosquito of the genus *Anopheles*, which obtains the spores from infected human beings and transmits them by biting other individuals. The *definitive host* is man. The parasites invade the red blood-corpuscles, absorb the pigment as they grow, becoming themselves pigmented, and, when fully matured, undergo segmentation, with the production of large numbers of spores. Rupture of the parasites liberates these spores, which enter other corpuscles and develop into mature parasites, repeating the

cycle of development, which varies in length, according to the species (tertian, quartan, estivo-autumnal, etc.).

The prophylaxis of malaria consists in preventing the inoculation of individuals by mosquitos. The latter are carriers, but never the originators of the disease. The measures that have been advised are: 1. Destruction of the breeding places of mosquitos by draining or filling up pools of stagnant water and by screening all open receptacles, such as cisterns and water barrels. 2. Prevention of mosquito contamination by screening from the insects all those affected with the disease, or by rapidly removing the parasites from the peripheral circulation by the proper administration of quinin. 3. Withdrawal to a distance of from five to six miles from localities where cases of malaria are present. 4. Preventing the multiplication of the parasites by the continuous exhibition of small doses of quinin.

How can malarial districts be made healthy?

By preventing the development of the mosquito larvæ by ditching and draining the breeding grounds and by the liberal use of petroleum where drainage is impracticable; by screening all houses in which malarial patients are confined. Eucalyptus trees are said to afford some protection against mosquitos.

What rules in public health administration should be promulgated to prevent the spread of pulmonary tuberculosis?

Expectoration on sidewalks and on the floors of all public places and public conveyances should be prohibited. Houses that have been inhabited by tuberculous inmates should be disinfected. All tuberculous cattle should be condemned and killed. Persons suffering from tuberculosis should not be allowed to prepare or distribute food.

How should a room recently occupied by a person suffering with tuberculosis be disinfected?

The room should be closed hermetically and thoroughly disinfected with formalin, after which the walls should be repapered or painted.

What principal hygienic direction should be given to a patient suffering from tuberculosis?

To live in the open air practically all the time and to drink at least three pints of milk and eat fresh meat once a day, or from six to ten eggs daily; to expectorate into a paper spit-cup, or some other appliance that can be burned; to avoid kissing and close bodily contact with other persons.

State the best means of disinfecting sputum.

The sputum should be received in a paper spit-cup, set in a metal box with a lid. The spit-cup is taken out of the container, burned, and another put in its place. Or, the sputum may be discharged into a china or enamel cup provided with a lid which is raised only when the suptum is deposited. The cup contains an antiseptic solution which destroys the bacilli as soon as they are deposited. The cup must be emptied and boiled at short intervals.

Discuss the theory of hereditary tendencies as applied to tuberculosis.

While there is no evidence that the disease is ever congenital, the children of tuberculous parents are usually weak and lacking in resistance. It is now believed that such children contract the disease from the mother, if she is tuberculous, or from other tuberculous members of the family. Association with a tuberculous individual is regarded as a stronger etiological factor than descent from tuberculous parents or ancestors.

What is the lowest temperature of steam at which pus cocci are destroyed?

At 240° F. the organisms are killed in a few minutes; steam at 212° F. kills them in about forty minutes.

What gases are most efficient as disinfectants?

Formaldehyd, chlorin, and ozone.

Give a thorough and feasible method of disinfecting a room that has been occupied by a small-pox patient.

The room should be closed and the cracks around doors and windows sealed with adhesive plaster. Formaldehyd gas is then introduced into the room through a keyhole with an apparatus specially designed for the purpose, and the room is kept tightly closed for at least twenty-four hours (see second question below).

Mention five satisfactory disinfectants and give indications for their use.

Formaldehyd for disinfecting rooms. Carbolic acid, 1 to 40, for disinfecting clothing. Bichlorid of mercury, 1 to 1000, for the hands and also for clothing. Oxalic acid for the hands and for porcelain ware. Chlorid of lime for disinfecting urine and feces, water-closets, etc.

Describe in detail the process of disinfection by formaldehyd (formalin).

Make the room as nearly air-tight as possible by sealing all openings and cracks with adhesive plaster. The contents of the room, mattresses, pillows, clothing, books, etc., must be fully exposed to the action of the gas. Place one pound of formalin for every 1000 cu. ft. of air-space in a Novy generator, start the generator, and allow the room to remain closed for one day.

What abnormal condition of the eyes is most common in school children?

Myopia.

What habits of school children tend to produce myopia?

Reading small or imperfect print; reading or writing in a faulty position, with insufficient or improper illumination, or when fatigued.

What diseases are incident to school life? How may these diseases be prevented?

The infectious diseases, diseases due to animal parasites infesting the exterior of the body, curvature of the spine, myopia, nervous diseases, and anemia.

The infectious and parasitic diseases may be prevented by early recognition and prompt removal of the affected pupils. For this purpose systematic *school inspection* is necessary. Curvature of the spine may be prevented by using properly constructed school furniture, disposed in such a way as to secure the best illumination, and by teaching the children to hold themselves properly when reading and writing. The same measures, with the additional precaution of using text-books with clear, large print, will combat the development of myopia and other refractive errors. Plenty of out-door exercise and a substantial hot lunch in the middle of the day minimize the occurrence of nervous diseases and anemia.

Give the sanitary dimensions of a school-room for fifty pupils.

A room 40 ft. long, 25 ft. wide, and 15 ft. high would give each pupil 300 cu. ft. (8.5 c.m.) of air-space, which, with good ventilation, is adequate for each child.

What precautions should be taken in school-rooms to protect the sight of scholars?

The walls of the room should be of a neutral tint and the light should enter in such a way as to fall over the left shoulders of the pupils, who must not sit facing the windows. Blackboards must not have a glossy surface and must not be placed between windows. Text-books should be printed in large, clear type on unglazed paper. Faulty posture in reading or writing must be corrected immediately. If towels are supplied, children suffering from an inflammatory disease of the eyes must be prohibited from using the general supply. All defects in vision are to be reported to the parents, who should consult a competent oculist and have them corrected.

State in a general way the maximum number of hours that primary pupils in the public schools should be kept at their tasks, and how frequently and in what manner such tasks may be varied and broken.

A half hour at one given task is sufficient; after that the character of the mental work should be changed. At the end of an hour's mental application five or ten minutes should be spent in light calisthenic exercises. During the course of three hours' study there should be a recess of twenty minutes in the open air. The intermission in the middle of the day for lunch should be about two hours, and the afternoon session, lasting two hours, should be interrupted by a fifteen minutes' recess.

What evil consequences frequently result from the excessive use of tobacco?

Catarrhal inflammation of the nose, mouth, pharynx, and larynx; nervous affections of the heart, palpitation, intermittence, and later myocar-

ditis; digestive troubles, anorexia, gastritis; insomnia, nervous tremors, muscular twitching; partial or complete temporary blindness (toxic amblyopia).

Mention some of the results of tobacco smoking in growing schoolboys in respect to the circulation, air-passages, vision, and mental application.

Smoking depresses the circulation and causes palpitation of the heart on the least exertion; it sets up a low-grade catarrhal inflammation of the upper air-passages, leads to chronic conjunctivitis, and impairs the powers of concentration and sustained mental application.

Define the term "quarantine," mention the principal quarantinable diseases, and give the rules for determining the length of time each should be quarantined.

The adoption of measures to prevent the introduction of disease from one country or locality into another. The word originally meant isolation for forty days (*quarante*, Italian, "forty").

The principal quarantinable diseases are: cholera, smallpox, yellow fever, scarlet fever, typhus fever, plague, dengue, diphtheria, relapsing fever, leprosy, and cerebrospinal fever. In cases of eruptive fevers (smallpox, scarlet fever) isolation of the patient is continued two weeks after the cessation of desquamation; in diphtheria, until two negative cultures have been obtained from the affected area; in cholera and dengue, two weeks after the disappearance of all symptoms.

Give a medical and hygienic plan for the inspection of immigrants who have just arrived at a seaport.

First examine the "bill of health" and the records of all cases treated during the voyage, as well as the list of passengers and crew. Then examine the entire ship's company for transmissible disease. If a case of infectious disease occurred during the voyage, disinfect all freight and clothing that has been exposed to the infection, and detain all the persons who have been exposed until the period of incubation of the disease has passed.

Mention methods to be employed for preventing epidemics of yellow fever in the tropics.

Since mosquitoes are the agents which transmit the disease, the important prophylactic measures are: (1) to prevent contamination of the mosquitoes by screening all infected persons; (2) to protect the well from the bites of mosquitoes by the same measures; (3) to destroy the larvæ of the mosquitoes in the breeding-places; (4) to cremate all persons who die of the disease.

Describe the necessary sanitary precautions during the prevalence of an epidemic of Asiatic cholera.

Isolate all persons affected and their attendants; observe strict quarantine of infected houses and districts; disinfect and remove all accumulations of filth, excreta, etc.; cremate those who have died of the disease. Guard the water-supply to prevent further contamination, and have all the

drinking water boiled before it is used. Protect the patients from flies by means of screens.

What are (a) toxins and (b) antitoxins? Give the theory on which the prophylactic and the medicinal use of antitoxins is based.

(a) Toxins are the products, more or less poisonous, elaborated by bacterial cells. (b) Antitoxins are specific bodies contained in the blood-serum which combine with and neutralize toxins; they are obtained from the serum of immunized animals.

It is a well-known fact that a person or animal cannot be immediately reinfected with the same disease, and it has been demonstrated that if an animal is injected with serum obtained from another animal which has recovered from a specific disease, the injected animal cannot be infected with the same specific disease.

On what generally accepted theory are toxins used for the prevention and cure of disease?

See preceding question.

Describe the manner in which antitoxin is prepared.

A virulent culture of the specific micro-organism is injected, under aseptic precautions, into the cellular tissue of the selected animal, usually a horse. After the animal has recovered from the symptoms thus produced, a second, stronger injection of the specific poison is administered, and these injections of progressively increasing virulence are continued at suitable intervals, until the injection ceases to be followed by any symptoms of the disease. The animal is then said to be immunized. Under strict aseptic precautions blood is then withdrawn from the jugular vein, received in sterile flasks, which are immediately stoppered and stored in refrigerators until separation of the clot and serum takes place. The serum is tested by animal inoculation to determine its antitoxic power, and, after the addition of a small quantity of carbolic acid, put up in glass tubes which are at once hermetically sealed. Each tube has marked on it the strength in units, either of the entire contents or that of each cubic centimeter, and the date after which the antitoxin loses its activity.

What is meant by natural and by acquired immunity from disease? Give an example of each.

Certain animals and human beings are insusceptible to certain diseases and cannot be infected with them. Dogs are not susceptible to tuberculosis or cholera; negroes are practically immune to yellow fever.

Acquired immunity is a condition of the body in which an antitoxin has been developed in the blood-serum as the result of (1) a previous attack of the disease; (2) the injection of attenuated virus of the disease, as in vaccination; or (3) the injection of antitoxin obtained from an immunized animal. Persons who have had an attack of small-pox or yellow fever are immune to those diseases; vaccination protects the individual against small-pox; the injection of a prophylactic dose of diphtheria antitoxin protects against the disease in the presence of the infection.

From what diseases may immunity be acquired in the case of persons who have suffered from these diseases? How is the knowledge of this fact utilized in the prevention of certain diseases?

Cholera, typhoid fever, typhus fever, pertussis, chicken-pox, mumps, measles, scarlet fever, small-pox, and yellow fever. Small-pox is prevented by vaccination, which produces in the individual an attenuated form of the infection.

MATERIA MEDICA AND THERAPEUTICS

Define materia medica and therapeutics.

Materia Medica.—That branch of medical science which treats of medicinal remedial agents of organic or inorganic origin, their nomenclature, source in nature, physical properties and chemical composition, methods of preparation, physiologic and toxic effects, and dosage.

Therapeutics.—The art of applying remedies for the correction of morbid conditions in the human body or for the relief of symptoms.

Define pharmacy.

The art of collecting, preparing, and dispensing drugs.

Define and describe alkaloids.

Nitrogenous vegetable substances of basic and alkaline character, the chief constituents of the active principles of the vegetable drugs, used as medicines or poisons. Alkaloids are odorless and colorless and of bitter taste, but combine with acids to form soluble crystalline salts, which are used in medicine in preference to the alkaloids themselves.

The Latin names of alkaloids end in *ina*, the English in *in*. *Example:* morphina, morph*in*. They are compounds of carbon, hydrogen, nitrogen, and usually oxygen, turn red litmus-paper blue, are insoluble in water, soluble in alcohol, and precipitated by tannic acid, which is an antidote for all alkaloids.

Define glucosids and give two examples.

Organic substances contained in plants which, when heated with a dilute mineral acid and water, or subjected to the action of a ferment, split up into a glucose and some other substance (alcohols, aldehyds, phenols). Their Latin names end in *inum*, the English in *in*. *Examples:* salic*in* and strophanth*in*.

Define tincture, extract, and ointment, and tell, as a rule, how many drops of a tincture are in a fluidram.

Tincture.—A solution in alcohol or aromatic spirits of ammonia of a non-volatile substance (exception: *tincture of iodin*).

Extract.—A solid or semisolid preparation made by evaporating a solution of the active constituents of vegetable drugs to the required consistency.

Ointment.—A fatty preparation, soft or solid at ordinary temperatures, with a base of petrolatum, lanolin, lard, olive oil, or other unctuous substance.

The number of drops to a fluidram varies greatly in different tinctures —say from 60 to 120.

What is a fluidextract?

A solution of a drug in alcohol or dilute alcohol, made by percolation and partial evaporation, so that 1 cc. of the solution represents 1 gm. of the drug.

What is the ordinary relative strength of a tincture to a fluidextract of the same drug?

Tinctures vary in strength from 5 to 50 per cent., the majority being 10 per cent. In fluidextracts 1 cc. is equivalent to 1 gm. of the drug extracted, hence fluidextracts are on the average ten times as strong as tinctures.

Define spirits.

Alcoholic solutions of volatile substances. Fourteen are solutions of volatile oils.

How do official waters, e. g., aqua camphoræ, differ from solutions, e. g., liquor calcis?

Aquæ (waters) are solutions of *volatile* principles in water; *liquores* (solutions) are made by dissolving *non-volatile* substances in water.

Define official preparations as applied to preparations of medicinal agents.

All drugs and preparations or mixtures of drugs that are recognized by the Pharmacopeia.

Define solvent. Mention three principal solvents.

Any liquid in which a substance is dissolved. The principal solvents used in medicine are water, alcohol, glycerin, oil, and dilute acetic acid.

What is an excipient? Give example.

Any substance used as a vehicle for a drug, such as syrups, flavoring extracts, mucilage, or ointments.

Define emulsion.

A mixture of water and oil or resin. The globules of oil or particles of insoluble resin are held in suspension by some gummy substance, usually acacia. Milk is a natural emulsion.

How do oleates and ointments differ?

Oleates are *liquid* solutions of metallic bases or alkaloids in oleic acid; ointments are *semisolid* fatty preparations with lard, petrolatum, etc., as a base. Both are used for external application.

Give the source and dose of spartein, eserin, picrotoxin, creosote, and pix liquida.

Spartein: alkaloid of scoparius; dose (spartein sulphate), $\frac{1}{4}$ to $\frac{1}{2}$ gr.

Eserin: alkaloid of physostigma or Calabar bean; dose (eserin sulphate), $\frac{1}{80}$ to $\frac{1}{40}$ gr.

Picrotoxin: a neutral principle derived from the seed of Anamirta paniculata or fishberry; dose, $\frac{1}{120}$ to $\frac{1}{60}$ gr.

Creosote: product of the dry distillation of wood-tar or derived from pyroligneous acid; dose, 2 to 5 min.

Pix liquida: tar; an oleoresin obtained by the destructive distillation of the wood of Pinus palustris (yellow pine) and other species of pines; dose, 5 to 10 gr.

Give the source of (a) acetanilid, (b) caffein, and (c) salol.

(a) The monacetyl derivative of anilin. (b) Alkaloid from coffee and tea. (c) Salicylic ester of phenol.

(a) How is opium obtained? (b) What per cent. of morphin should it normally yield? (c) Name two alkaloids of opium and give doses.

(a) Opium is the concrete, milky exudation obtained by incising the unripe capsules of Papaver somniferum, or poppy. (b) Not less than 9 per cent. (c) Morphin (sulphate) $\frac{1}{4}$ gr.; codein (phosphate) $\frac{1}{2}$ gr.

Give two derivatives of morphin used in medicine, with dose of each.

Heroin (diacetylmorphin): dose of the hydrochlorid, $\frac{1}{24}$ to $\frac{1}{12}$ gr. *Apomorphin:* an alkaloid prepared from morphin by the abstraction of one molecule of water; dose of the hydrochlorid (expectorant), $\frac{1}{30}$ gr; (emetic), $\frac{1}{10}$ gr.

Where is the habitat of belladonna?

Europe and Asia Minor.

What is the source of camphor? State the dose of spiritus camphoræ.

The branches and chipped wood of Cinnamomum camphora or camphor tree. Habitat: China and Japan. The wood is exposed to the vapor of boiling water and the volatilized camphor is condensed and refined by sublimation. It is also obtained by tapping the trees and collecting the exudate.

Dose of spirits of camphor, 5 to 15 min.

From what source besides nux vomica is strychnin obtained? What other alkaloid is obtained from the same sources?

The seed of Strychnos ignatia. Brucin.

Where is the cinchona tree indigenous? What part of the tree is used in medicine?

In the Andes of tropical South America. The bark.

What are the sources of salicylic acid?

It is generally prepared artificially from carbon dioxid and phenol. It exists naturally in combination in wintergreen, sweet birch (Betula lenta), and other plants.

What is the source of aloes? By what part of the intestinal tract is it eliminated?

Aloe socotrina and other species of aloe; aloes is the inspissated juice of the leaves. Aloes is said to act chiefly, if not exclusively, on the large intestine.

Where is colocynth obtained and for what is it used?

Colocynth is the peeled dried fruit of Citrullus colocynthis, or bitter apple, a native of Spain, Greece, Southern and Western Asia, and Northern Africa. It is used chiefly in combination with other cathartic drugs, especially in *compound cathartic pills*, which contain $\frac{1}{3}$ gr. of the compound extract of colocynth.

Where is jalap indigenous? What part of it is used in medicine?

In Mexico. The root is the part used.

Where is quassia indigenous? What part of the plant is used in medicine?

Quassia is the wood of Picræna excelsa, a native of Jamaica. The wood.

Give the source and preparations of gum arabic.

Gum arabic, or acacia, is the gummy exudate of Acacia Senegal, a small African tree. The following preparations are official: pulvis acaciæ, mucilago acaciæ, and syrupus acaciæ.

What is the source of carbo ligni? What are the therapeutic uses of carbo ligni?

Charcoal is prepared from soft wood and very finely powdered. It is used to check meteorism and flatulence and as a mild laxative. It is also a cheap and efficient deodorant.

Where is the cinnamon tree indigenous? Mention the active principle of cinnamon and give its dose.

Ceylon and China. A yellowish, volatile oil, *oleum cinnamomi*. The *dose* is 1 to 3 drops, as an adjuvant or to disguise the taste of unpleasant mixtures.

State the source and give the uses of saccharin.

An intensely sweet, white, crystalline powder, about three hundred times as sweet as sugar, prepared from toluene, a coal-tar derivative, and sulphuric acid. It is used as a substitute for sugar in diabetes and other conditions in which sugar is contraindicated. It may also be given to acidify ammoniacal urine, as in cystitis.

By what process and from what source is sugar of milk principally obtained?

Sugar of milk is obtained from the whey of cows' milk by evaporation and purified by recrystallization.

Give the chief source and the dose of gallic acid.

A paste of nutgall and water is exposed to the air for a month, the water is expressed and rejected, and the residue boiled with water, filtered through animal charcoal, and allowed to crystallize. *Dose:* 15 gr.

What are the therapeutic uses of picrotoxin?

Locally, in decoction or ointment form, as a parasiticide in scabies and tinea versicolor; *internally* in doses of $\frac{1}{180}$ to $\frac{1}{60}$ for the night-sweats of phthisis and in exophthalmic goiter.

What is the source from which eserin is obtained? How and for what purpose is eserin principally used?

Physostigma venenosum. Eserin or *physostigmin* is the alkaloid obtained from the seeds. It is chiefly used in ophthalmologic practice as a *miotic* (to contract the pupil and reduce intra-ocular tension). It is also recommended in typhoid fever and as a prophylactic before operations on the intestines, to combat intestinal atony and distention.

Give the source, the common name, and the principal therapeutic uses of Oleum theobromæ.

The common name is cacao-butter. It is used as a base for suppositories.

Give the source and describe the uses of lanolin.

It is a favorite base for ointments, as it is said to be more quickly absorbed than most fats.

What are the sources of sulfur?

Sulfur sublimatum, or *flowers of sulfur*, is obtained by sublimation from crude sulfur or native sulfids of iron and copper; *precipitated sulfur* and sulfur lotum, or *washed sulfur*, are prepared from the flowers.

State the source of ichthyol and give its uses in medicine.

A bituminous quartz, containing the fossil remains of fish, and found in the Tyrol, is distilled with sulfuric acid; the acid is removed with sodium chlorid and the distillate saturated with ammonia.

Ichthyol is used *externally* in eczema, psoriasis, acne, and erysipelas; inflamed and rheumatic joints; contusions; sprains; glandular swellings; and inflammatory affections of the female genitalia.

Name five changes of the official Latin titles in the eighth revision of the U. S. P.

Acidum arsenosum to *arseni trioxidum;* acidum carbolicum to *phenol;* acidum chromicum to *chromii trioxidum;* aloe Barbadensis to *aloe;* alumini hydras to *alumini hydroxidum.*

Give official names of wahoo, pennyroyal, cornsilk, oxgall, nutmeg, chamomile, hemlock, yellow jasmine, and Rochelle salts.

Euonymus, hedeoma, zea mays, fel bovis, myristica, anthemis, conium, gelsemium, and potassii et sodii tartras.

(a) Give the Latin title of paregoric; (b) name all its constituents; and (c) give the amount of the principal drug in 1 oz. of the mixture.

(a) Tinctura opii camphorata. (b) Powdered opium, benzoic acid, camphor, oil of anise, glycerin, and diluted alcohol. (c) 1.82 gr.

Give the official name and the composition of (a) Fowler's solution and (b) Donovan's solution.

(a) Liquor potassii arsenitis contains 1 per cent. arsenic trioxid, 2 per cent. potassium bicarbonate, and 3 per cent. compound tincture of lavender to color. (b) Liquor arseni et hydrargyri iodidi contains 1 per cent. each of arsenous iodid and the red iodid of mercury.

What is the official name of tartar emetic? State the dose of tartar emetic.

Antimonii et potassii tartras. *Dose:* $\frac{1}{16}$ to $\frac{1}{2}$ gr.

By what other names is saltpeter known?

Potassium nitrate and niter.

What is the common name of guaiacum? What are the therapeutic uses of guaiacum?

The common name is lignum vitæ. The simple or ammoniated tincture, in doses of one to two teaspoonfuls, is used in tonsillitis, sciatica, and subacute and chronic rheumatism.

Give the common name of taraxacum and state what part of the plant is used in medicine.

Dandelion. The root is used in medicine.

What is the vulgar name of physostigma?

Calabar bean.

What is the common name of serpentaria?

Virginia snake-root.

Name the official preparations and doses of digitalis, cascara sagrada, ipecacuanha, and strophanthus.

Digitalis: powder, 1 gr.; extract, $\frac{1}{4}$ to $\frac{1}{2}$ gr.; fluidextract, 1 to 3 min.; infusion, 1 to 4 dr.; tincture, 5 to 20 drops.

Cascara sagrada, the fluidextract, $\frac{1}{2}$ to 1 dr.

Ipecacuanha: fluidextract, *emetic dose,* 15 min.; *expectorant,* 1 min.; pulvis ipecacuanhæ et opii (Dover's powder), 5 to 10 gr.; syrup, *expectorant dose,* 15 min.; *emetic,* 4 fl. dr.; wine, 15 min.

Strophanthus: tincture, 5 to 45 min.

Give the botanical name of digitalis.

Digitalis purpurea.

Name the official preparations of belladonna and the dose of those used internally.

Extractum belladonnæ foliorum. *Dose:* $\frac{1}{12}$ to $\frac{1}{4}$ gr.; tinctura belladonnæ foliorum, 5 to 30 min.; fluidextractum belladonnæ radicis, 1 to 2 min.; emplastrum belladonnæ; unguentum belladonnæ; linimentum belladonnæ.

Name three official preparations of camphor.

Aqua camphoræ, linimentum camphoræ, and spiritus camphoræ.

Name the three most used preparations of opium, and state how much of each contains 1 gr. of opium.

Pulvis ipecacuanhæ et opii (Dover's powder), 10 gr.; tinctura opii (laudanum), 10 min.; tinctura opii camphorata (paregoric), 1 to 4 dr.

State the name and dose of each of five official preparations of opium.

Powdered Opium, $\frac{1}{2}$ to 1 gr.; extract of opium, $\frac{1}{4}$ to 1 gr.; tincture of opium, 10 to 30 drops; camphorated tincture of opium (paregoric), 1 to 4 dr.; wine of opium, 5 to 10 drops.

(a) Name ten official preparations of mercury. (b) Name four alkaloids of opium.

(a) Hydrargyrum cum creta, massa hydrargyri, hydrargyri chloridum mite, hydrargyri chloridum corrosivum, hydrargyri iodidum flavum, hydrargyri iodidum rubrum, unguentum hydrargyri, unguentum hydrargyri ammoniati, unguentum hydrargyri oxidi flavi, unguentum hydrargyri nitratis, liquor arseni et hydrargyri iodidi (Donovan's solution).
(b) Morphin, codein, thebain, and narcotin.

Mention the salts of silver used in medicine and give the dose of each.

The nitrate, dose, $\frac{1}{4}$ to $\frac{1}{2}$ gr.; iodid, $\frac{1}{4}$ to 1 gr.; oxid, $\frac{1}{2}$ to 1 gr.; lunar caustic (argenti nitras fusus), for external use. The cyanid is used in pharmacy for the preparation of hydrocyanic acid.

Name the official preparation of gold and describe its therapeutic uses.

The only official preparation is the gold and sodium chlorid (*auri et sodii chloridum*). It is little used, but has been recommended in gastrointestinal disorders, Bright's disease, and tertiary syphilis.

Describe gelsemium. State the dose of the preparations of gelsemium.

Yellow jasmine is the rhizome and roots of Gelsemium sempervirens, a climbing plant of the natural order Loganaceæ. It grows in the forests of the southern United States. It contains a volatile oil, a resin, and an alkaloid, *gelsemin,* in combination with gelsemic acid. The preparations are the fluidextract, dose, 2 to 20 min.; the tincture, dose, 10 min. to 1 dr.

Give the habitat of squills and state which of its preparations are used in medicine.

It is native to southern Europe. The preparations are the vinegar, syrup, and tincture.

Name the preparations of Secale cornutum and give the dose of each.

The preparations of Secale cornutum ("spurred rye") or *ergot* are: powdered ergot (ergota), dose, ½ to 2 dr.; the extract, 5 to 30 gr.; the fluidextract (most used), 10 to 60 min.; the wine, 2 fl. dr. to 2 fl. oz.

Mention the official turpentines. State whence they are obtained.

There are two official turpentines: (1) *terebinthina*, or common American white turpentine, a concrete oleoresin from Pinus palustris, the yellow pine, and other species of Pinus, natural order Coniferæ; and (2) *terebinthina canadensis*, Canada turpentine or Canada balsam, a liquid oleoresin obtained from Abies balsamea, or American silver fir.

What official preparations are derived from the willow?

Salicin, a glucosid obtained from several species of Salix and Populus.

Of what is iodoform a preparation and what is the dose for internal administration?

Iodin, of which it contains 96.7 per cent. *Dose:* ½ to 2 gr.

Mention three principal salts of potassium used in medicine and give the dose of each.

Potassium bromid, ½ to 2 dr.; potassium acetate, ½ to 1 dr.; potassium bicarbonate, ½ to 1 dr.

Name four official pills and give the principal ingredients of each.

1. Compound cathartic pills contain calomel, jalap, gamboge, and compound extract of colocynth.
2. Pilulæ ferri carbonatis, or Blaud's pills, contain ferrous sulphate, potassium carbonate, sugar, tragacanth, and althea.
3. Pills of asafetida contain asafetida and soap.
4. Blue pills (pilulæ hydrargyri) contain mercury, glycyrrhiza, and althea.

Give the composition of (a) black wash and (b) Dover's powder.

(a) Mild chlorid of mercury, 1 dr.; lime-water, 1 pint. (b) Ipecac, 10 per cent.; powdered opium, 10 per cent.; sugar of milk, 80 per cent.

Mention the ingredients of Tully's powder.

Tully's powder is the compound powder of morphin. It contains one part of morphin sulfate to nineteen of camphor, and twenty each of licorice and calcium carbonate.

Name the ingredients of the following: (a) compound chalk powder; (b) compound licorice powder; (c) Carron oil.

(a) Prepared chalk, powdered acacia, and powdered sugar. (b) Senna, licorice, oil of fennel, washed sulfur, and sugar. (c) Lime-water and linseed oil.

Give the composition of the official compound cathartic pill.

Compound extract of colocynth, 130 gr.; abstract of jalap, 100 gr.; mild chlorid of mercury, 100 gr.; gamboge, 25 gr. These quantities, properly prepared, make one hundred pills.

(a) What is the most active laxative ingredient in pulvis glycyrrhizæ compositus? (b) What is the dose of the powder?

(a) Senna. (b) 1 dr.

What is the composition of hydrargyri iodidum rubrum?

Bichlorid of mercury and potassium iodid.

What is the composition of linimentum calcis? For what is it principally used?

Carron oil consists of equal parts of lime-water and linseed oil, and is employed chiefly in the treatment of burns.

Describe the preparation of lime-water. Give the official name and the adult dose.

Lime-water is prepared by pouring two quarts of hot water over fresh, unslaked lime the size of a walnut; stir till slaked, let it stand until clear, and bottle. A funnel with filter-paper is filled with unslaked lime and the desired quantity of water poured through the filter.

Liquor calcis is the official name; the dose is ½ to 2 oz.

Give the composition and state the uses of lotio hydrargyri flava.

Yellow wash contains the yellow oxid of mercury and is prepared by adding ½ dr. of corrosive sublimate to 1 pt. of lime-water. It is used on syphilitic sores.

What is the composition of so-called green soap?

Green soap is prepared from potassa and olive oil.

State the ingredients and uses of sulfur ointment.

Precipitated sulfur, 30 parts; benzoinated lard, 70 parts. It is used as a stimulating application in chronic eczema and in the treatment of scabies, as it kills the itch-mite.

Give the composition of Vienna paste.

Equal parts of potassa and lime rubbed up into a paste.

How is liquor ammonii acetatis prepared? In what conditions is this preparation useful?

By adding to dilute acetic acid enough ammonium carbonate to neutralize. Being a feeble refrigerant, diaphoretic, and diuretic, it is used chiefly as a menstruum for fever mixtures in adynamic fevers. It is also employed to relieve the effects of acute alcoholism.

State the composition and method of preparing liquor potassii citratis. Should it be freshly prepared? Has the strength of liquor ferri et ammonii acetatis been increased or decreased in the eighth revision of the U. S. P., and to what extent?

Potassium bicarbonate, citric acid, distilled water. Dissolve the potassium bicarbonate and the citric acid, each, in distilled water. Filter the solutions separately. Mix the two solutions and, when effervescence ceases, transfer the liquid to the bottle. This preparation should be freshly made. The strength of liquor ferri et ammonii acetatis was changed from 2 per cent. to 4 per cent. in the eighth revision of the U. S. P.

Why should you prescribe the salts of the alkaloids instead of the alkaloids themselves?

Because the salts are freely soluble in water, while the alkaloids themselves are practically insoluble.

Describe and classify the important active principle of each of the following drugs: hydrastis canadensis, veratrum viride, and humulus.

Hydrastis canadensis: *hydrastin*, a white alkaloid. Veratrum viride: the alkaloid *jervin*, a white powder insoluble in water, ether, and alcohol, but soluble in chloroform, is the active principle. Another constituent alkaloid is *veratroidin*. Humulus: a bitter principle and a volatile oil.

Mention three alkaloids which are chemically alike and almost identical in physiologic effect.

Cinchonin, cinchonidin, and quinidin.

What active principles are found in digitalis? What are the official preparations of petroleum?

Digitalin, digitoxin, digitalein, digitonin, and digitin.

The official preparations of petroleum are petrolatum, petrolatum album, and petrolatum liquidum.

Give the principal alkaloid of belladonna and indications for its use; also dose.

Atropin: *dose*, $\frac{1}{200}$ to $\frac{1}{50}$ gr. The *indications* for its use are: (1) To relieve spasm. (2) To diminish the secretion of the salivary glands, of the stomach, of the Schneiderian membrane (coryza), of the sweat-glands (night-sweats), and of the mammary glands. (3) As a vasomotor stimulant in shock and as a respiratory stimulant (ether narcosis). (4) To relieve

pain in neuralgia (injected into the region of the affected nerve). (5) As an antidote in opium-poisoning. (6) In ophthalmology to dilate the pupil and paralyze accommodation for purposes of refraction; to prevent or break up adhesions of the iris and inflammatory conditions of the cornea.

Describe the alkaloid strychnin, and give a test for determining its presence.

Strychnin is an alkaloid derived from the seed of Strychnos nux-vomica, a tree of the natural order Loganaceæ, growing in India and China. Strychnin and its salts dissolve without color in concentrated sulfuric acid, but, on adding to the solution lead peroxid, a beautiful blue color results, passing into violet, then red, and finally yellow.

Mention the alkaloids of nux vomica.

Strychnin and brucin.

What part of scoparius is used in medicine? What alkaloid is derived from scoparius?

The tops of Cytisus scoparius. The alkaloid is *spartein.*

Give the name of the alkaloid of Calabar bean and state its dose.

Physostigmin (or eserin). The dose of the sulphate is $\frac{1}{100}$ to $\frac{1}{40}$ gr.

Mention the chief alkaloids and the therapeutic class of belladonna and of Calabar bean.

Belladonna contains two alkaloids, the official atropin and belladonnin. Belladonna is a *delirifacient.* Calabar bean contains physostigmin and calabarin. It is a *depressomotor.*

What is the alkaloid of hyoscyamus? What is the dose of hyoscyamus? What is the dose of hyoscin hydrobromate for hypodermic use?

Hyoscyamin. The dose of the extract of hyoscyamus is $\frac{1}{2}$ to 3 gr. The dose of *hyoscin hydrobromate* for hypodermic use is $\frac{1}{200}$ to $\frac{1}{50}$ gr.

What part of aconite is used in medicine? What is the alkaloid of aconite?

The root or tuber of Aconitum napellus, or monk's-hood. Aconitin.

What is the vulgar name for veratrum? What is its active principle and the dose?

American or swamp hellebore. Its action is due chiefly to *veratrin,* one of its contained alkaloids, which is not used. The dose of *tinctura veratri* is 2 to 5 drops.

Name six drugs containing large quantities of tannic acid.

Galla, krameria, kino, hematoxylon, catechu, hamamelis.

Select ten of the following drugs. Regarding each of the ten state: (a) adult dose, (b) therapeutic use, (c) symptoms produced by an overdose. Write the name of the drug at the beginning of the answer which applies to it: (1) Tartar emetic, (2) nitrate of silver, (3) salicylate of bismuth, (4) sulfid of calcium, (5) camphor, (6) sulfate of codein, (7) arsenite of copper, (8) tincture of the chlorid of iron, (9) tincture of gelsemium, (10) guaiacol, (11) corrosive sublimate, (12) veratrum, (13) chlorate of potassium, (14) hexamethylenamin, (15) nitroglycerin.

1. *Tartar emetic:* (a) $\frac{1}{16}$ gr. (expectorant). (b) Expectorant in laryngitis, bronchitis, and asthma (rarely used). As an *emetic* the drug has gone out of use. (c) Vomiting, profuse sweating, violent muscular cramps, weak pulse, diarrhea and bloody stools, collapse, convulsions, and death.

2. *Nitrate of silver:* (a) $\frac{1}{4}$ gr. (b) Astringent and stimulating in gastric ulcer and other affections of the gastro-intestinal tract. (c) Abdominal pain, purging and vomiting of white curds (silver chlorid), staining of lips, first brown and then black; headache, vertigo, unconsciousness, and epileptiform convulsions. Death from asphyxia.

3. *Salicylate of bismuth:* (a) 10 gr. (b) Sedative, antiseptic, and astringent to gastro-intestinal mucous membrane (vomiting, diarrhea). (c) Diarrhea, violent intestinal irritation, stomatitis. Fatal poisoning is rare.

4. *Camphor:* (a) 5 to 10 gr. (b) Sedative and antispasmodic; mild diaphoretic; rapid but fugacious heart stimulant. (c) Dizziness, headache, delirium, epileptiform convulsions, stupor, and coma.

5. *Sulfate of codein:* (a) $\frac{1}{4}$ to $\frac{1}{2}$ gr. (b) Hypnotic, sedative expectorant, mild analgesic. It has the same action as morphin, but is less powerful and less reliable. It is much used in diabetes mellitus. (c) The same as morphin: profound sleep, slow and shallow respirations, slow full pulse, contracted pupils. Death results from paralysis of the respiratory center.

6. *Tincture of the chlorid of iron:* (a) 10 to 20 min. (b) Astringent, mildly diuretic, and chalybeate. Used empirically in erysipelas, diphtheria, and scarlet fever, and in various forms of anemia. (c) Constipation and headache.

7. *Corrosive sublimate:* (a) $\frac{1}{32}$ gr. (b) Used in combination with potassium iodid in tertiary syphilis; also as a general tonic and alterative. (c) Gastro-intestinal irritation, with great pain in stomach coming on rapidly; vomiting; purging and the discharge of bloody mucus; albuminous and bloody urine; collapse and death.

8. *Veratrum:* (a) 3 to 6 min. of the tincture. (b) To depress and lower the heart action and arterial tension in the beginning of pneumonia and in cardiac hypertrophy. (c) Vomiting, pain in abdomen, great prostration, cold sweats, feeble, slow pulse, dilatation of the pupils, vertigo, convulsions, and loss of consciousness; death from paralysis of respiration.

9. *Chlorate of potash:* (a) 5 to 10 gr. (b) Internally and in a gargle or mouth-wash in stomatitis, tonsillitis and pharyngitis, and the "sore throat" of scarlet fever. (c) Diarrhea, vomiting, labored breathing, and

cyanosis due to the conversion of the oxyhemoglobin of the blood into methemoglobin.

10. *Hexamethylenamin* (urotropin—formin): (a) 5 to 10 gr. (b) Diuretic and antiseptic to intestinal and genito-urinary tract.

State the dose of (a) nitroglycerin, (b) wine of colchicum (sem.), and (c) extract of colocynth.

(a) $\frac{1}{100}$ gr. (b) $\frac{1}{2}$ to $1\frac{1}{2}$ fl. dr. (c) 2 to 5 gr.

State the dose of (a) aconitin, (b) picrotoxin.

(a) $\frac{1}{300}$ to $\frac{1}{200}$ gr. (b) $\frac{1}{120}$ to $\frac{1}{60}$ gr.

State the dose of (a) tincture of aconite, (b) fluidextract of belladonna, (c) fluidextract of conium.

(a) 1 to 4 min. (b) 1 to 2 min. (c) 1 to 15 min.

Give the dose of (a) caffein, (b) wine of ipecac, (c) tincture of veratrum.

(a) 2 to 10 gr. (b) 2 to 6 fl. dr. (c) 3 to 6 min.

What is the adult dose of (a) sulfate of atropin, (b) tincture of cantharides, (c) tincture of colchicum?

(a) $\frac{1}{250}$ to $\frac{1}{100}$ gr. (b) 1 to 5 min. (c) 5 to 20 min.

Give the maximum doses of the following: (a) acetanilid, (b) atropin sulfate, (c) beechwood creosote, (d) bichlorid of mercury, (e) extract of cannabis indica.

(a) 5 gr.; (b) $\frac{1}{60}$ gr.; (c) 10 min.; (d) $\frac{1}{10}$ gr.; (e) $\frac{1}{2}$ gr.

State the dose for an adult of (a) acetanilid, (b) tartar emetic, (c) silver nitrate.

(a) 3 to 5 gr.; (b) $\frac{1}{16}$ gr. as expectorant; $\frac{1}{2}$ to 1 gr. as emetic; (c) $\frac{1}{4}$ gr.

Give hypodermic dose of the following: sulfate of strychnin, sulfate of atropin, sulfate of morphin, apomorphin hydrochlorate, nitroglycerin, and pilocarpin hydrochlorate.

Sulfate of strychnin, $\frac{1}{30}$ to $\frac{1}{10}$ gr.; sulfate of atropin, $\frac{1}{250}$ to $\frac{1}{100}$ gr.; sulfate of morphin, $\frac{1}{4}$ gr.; apomorphin hydrochlorate, $\frac{1}{10}$ gr. (emetic); nitroglycerin, $\frac{1}{100}$ gr.; pilocarpin hydrochlorate, $\frac{1}{20}$ to $\frac{1}{10}$ gr.

Give the adult dose of phosphorus, arsenious acid, tincture of belladonna, and tincture of aconite.

Phosphorus, $\frac{1}{100}$ gr.; arsenious acid (arsenic trioxid), $\frac{1}{60}$ to $\frac{1}{40}$ gr.; tincture of belladonna, 5 to 20 min.; tincture of aconite, 1 to 4 min.

Give the average adult dose of the following: (1) liquor potassii arsenitis, (2) tinctura nucis vomicæ, (3) tinctura opii, (4) hydrargyri chloridum corrosivum, (5) atropinæ sulphas, (6) cocainæ hydrochloridum, (7) tinctura veratri, (8) spiritus glyceritis nitratis, (9) oleum tiglii, (10) eserina.

(1) 8 min.; (2) 15 min.; (3) 10 min.; (4) $\frac{1}{32}$ gr.; (5) $\frac{1}{150}$ gr.; (6) $\frac{1}{4}$ gr.; (7) 3 min.; (8) 1 min.; (9) 2 drops; (10) $\frac{1}{50}$ gr.

Give the doses for (1) Norwood's tincture of veratrum, (2) tincture of digitalis, (3) tincture of gelsemium, (4) tincture of belladonna, (5) sodium salicylate, (6) podophyllin, (7) calomel, (8) cimicifuga, (9) muriatic acid, (10) bichlorid of mercury.

(1) 1 to 3 min.; (2) 5 to 15 min.; (3) 2 to 10 min.; (4) 5 to 20 min.; (5) 10 to 20 gr.; (6) $\frac{1}{6}$ gr. (of the resin); (7) 1 to 2 gr. in fractional doses (laxative), $\frac{1}{4}$ gr. (diuretic); (8) 30 gr.; (9) 5 min., well diluted; (10) $\frac{1}{32}$ gr.

State the dose of (a) tincture of quassia, (b) caffein, (c) fluidextract of ergot, (d) infusion of digitalis.

(a) 1 to 2 fl. dr.; (b) 2 to 8 gr.; (c) 1 to 2 fl. dr.; (d) 2 to 4 fl. dr.

Give the general rule for calculating doses for children.

Young's Rule: Divide the age by the age *plus* twelve. The resulting fraction will indicate the part of the adult dose to be used. This rule holds for all ages over one year.

What are the modes of administration of medicines? How does dosage vary in each with dosage by the mouth?

By the mouth and stomach; hypodermically; intravenously; by inunction; by inhalation; by rectal injection. Hypodermic and intravenous doses should be one-fourth smaller, while the rectal dose should usually be one-fourth larger, than the dose given by the mouth.

No definite rule can be given, as different drugs vary greatly in respect to rapidity and completeness of absorption.

Give dose and antidote for an overdose of each of the following: (a) extract of physostigma, (b) tincture of strophanthus, (c) Indian hemp, (d) tincture of aconite, (f) corrosive sublimate.

(a) $\frac{1}{6}$ gr.; *tannic acid.* (b) 8 min.; *tannic acid.* (c) $\frac{1}{2}$ gr.; *emetics.* (d) 3 min.; *tannic acid.* (e) $\frac{1}{32}$ gr.; *albumen* (white of egg).

Give the chemical name and the dose of (a) Epsom salts, (b) Rochelle salts, (c) Glauber's salts.

(a) Magnesium sulfate; $\frac{1}{2}$ oz. (b) Potassium and sodium tartrate; $\frac{1}{2}$ to 1 oz. (c) Sodium sulfate; 2 dr. to $\frac{1}{2}$ oz.

What is the proportion of mercury in hydrargyrum cum creta? What is the dose?

Thirty-eight per cent.; *dose,* 5 to 20 gr.

Compare the strength of dilute hydrochloric acid with that of the absolute acid. What is the dose of the former?

Dilute hydrochloric acid is a 10-per cent. solution of the absolute acid in water. The *dose* is 10 to 20 min.

Give the dose (a) liquor potassii arsenitis, (b) liquor sodii arsenitis.

The dose is the same for both, 2 min., cautiously increased to 10 min.

How many grains of the hydrochlorate of cocain are contained in 1 oz. of a 10-per cent. solution?

Forty-eight grains.

Mention the preparations of ergot and give the dose of each preparation.

Powdered ergot, $\frac{1}{2}$ to 2 dr.; extract, 5 to 20 gr.; fluidextract, 1 to 2 fl. dr.; wine, 2 fl. dr. to 1 fl. oz.; ergotin (not official), 3 to 10 gr.

What part of buchu is used in medicine? State the dose of the fluidextract of buchu.

The leaves. The dose of the fluidextract is 1 fl. dr.

What is the dose of curare for hypodermic use? What are the antagonists of curare?

$\frac{1}{20}$ to $\frac{1}{4}$ gr. Atropin, strychnin, and other respiratory stimulants.

Mention the conditions which affect the dosage of medicines.

(1) Age; (2) individual susceptibility; (3) condition of the heart and kidneys; (4) absorptive powers of patient (diminished in shock).

Name and describe the methods of introducing medicines into the circulation.

(1) By the *mouth.* The drug, either solid or liquid, is swallowed and absorbed in the stomach and small intestine.

(2) By the *rectum* in liquid (enema) or semisolid form (suppositories); the drug is absorbed by the large intestine. The rectal dose should be roughly about double that given by the mouth, or somewhat less in the case of narcotics.

(3) *Hypodermic method.* The drug in solution in sterile water, salt solution, or oil, or protective and curative serums, is injected with a hypodermic needle into the subcutaneous areolar tissue, usually of the arm, thigh, or abdomen. Perfect asepsis is required. The hypodermic dose should be about one-fourth less than the dose by mouth.

(4) *Epidermic* or *inunction method.* The skin is thoroughly cleansed with soap and water and then with alcohol, and the ointment (*mercurial ointment in syphilis*) containing the drug, oil, or other unguent (*cod-liver oil, butter in marasmus*) rubbed into the skin. The flexor surfaces of the arms and thighs and the front of the chest and abdomen are the sites selected.

(5) *Inhalation method.* Volatile drugs are rapidly absorbed by the respiratory mucous membrane (*ether, chloroform,* etc.). The vapor of water may be medicated with the drug and inhaled, usually for local effects. Mercury may be administered in a *vapor bath* for its systemic effect.

(6) *Intravenous method.* Used in cases of emergency when rapid action is desired; for the introduction of saline solution; and for certain drugs that cannot be injected into the subcutaneous tissue (*adrenalin chlorid, collargol*). The needle is introduced into the vein, exposed by a preliminary skin incision, or directly by thrusting it through the skin.

The *enepidermic* application to the skin without friction, and *endermatic* application of a drug to a surface denuded of epidermis by vesication, are now obsolete.

State the precautions which should ordinarily be observed in administering medicines by the hypodermic method.

The skin at the site of injection must be cleansed with soap and water and alcohol or bichlorid solution to render it aseptic. The water or other solvent containing the drug and the hypodermic needle must be sterile, and the injection must be made into the subcutaneous tissue or into the muscle. Blood-vessels and nerves must be avoided.

What is incompatibility in medicine, and what are the different kinds of incompatibles? Give an example of each.

Two or more drugs are incompatible when they cannot be administered in the same mixture or at the same time. Drugs may be *chemically*, *physically* (*pharmaceutically*), or *therapeutically* incompatible.

(a) *Chemical incompatibility* occurs when substances precipitate each other in solution (unless intentional), form explosive compounds or volatile ingredients, or when chemical decomposition takes place. *Example:* Sodium bicarbonate with dilute hydrochloric acid forms carbon dioxid.

(b) *Physical incompatibility:* Precipitates are formed without chemical action, usually resulting in unsightly mixtures. *Example:* infusion of digitalis with tincture of nux vomica forms a precipitate.

(c) *Therapeutic incompatibility* takes place when drugs of antagonistic physiologic action are combined. *Example:* strychnin sulfate and aconitin.

Mention three classes of evils which may result from chemical incompatibility in prescriptions.

Explosions. Formation of poisons. Formation of insoluble or inert substances.

Write a prescription illustrating chemical incompatibility.

January 1, 1908.

For G. W. Smith.

℞. Potassii iodidi,	ʒij;
Strychninæ sulphatis,	gr. ss;
Ferri sulphatis exsiccati,	ʒj;
Syrupi simplicis,	f℥j;
Aquæ,	q. s. ad f℥iij.

M. Sig.—One teaspoonful three times a day after meals.

Dr. T. L. Jones.

Potassium iodid is incompatible with the alkaloid and also with the metal salt.

How does an antagonist differ from an antidote?

Antagonists are drugs which are opposed to each other in their *physiologic* effects. An *antidote* is an agent administered for the purpose of counteracting the action of a poison, removing it from the body, or preventing its absorption.

Antidotes may be (a) *Chemical*—the nature of the poison is chemically changed so that it becomes insoluble or harmless.

(b) *Mechanical*—absorption of the poison is prevented by holding it in mechanical suspension or by coating the stomach.

(c) *Physiologic*—supplies its own peculiar and neutralizing effect upon the system.

Mention the antagonists of cocain.

Morphin, chloral, amyl nitrite, alcohol, chloroform, and ether.

What drug is antagonistic to pilocarpin?

Atropin sulfate is directly opposite in action; $\frac{1}{100}$ gr. neutralizes the effect of $\frac{1}{6}$ gr. of pilocarpin.

Name four drugs incompatible with iodid of potassium, two with atropin, and one with antipyrin.

(a) Hydrochloric acid, strychnin, and alkaloids generally; silver nitrate and bismuth subnitrate.

(b) Tinctura krameriæ (the tannin forms an insoluble tannate with atropin); physostigmin (physiologic antagonist).

(c) Sodium salicylate, quinin sulfate, chloral.

Name three drugs incompatible with belladonna and two incompatible with pilocarpin.

Caustic alkalis, potassium, sodium, and lithium hydroxid, and all vegetable astringents containing tannic acid are incompatible with belladonna. The same drugs are incompatible with pilocarpin, as are also the ferric and metallic salts (see also previous question).

Name four drugs incompatible with tannic acid. Name two incompatible with hyoscyamus.

(a) Atropin, tartar emetic, zinc sulfate, and silver nitrate. (b) The incompatibles of hyoscyamus are the same as those of belladonna—the caustic alkalis and vegetable infusions containing tannic acid.

What results from combining silver nitrate and creosote?

An odorless, white emulsion which is explosive.

How would you remove iodin stains?

With ammonia water.

How would you remove the stains of potassium permanganate and of ink?

By applying a solution of oxalic acid.

How would you remove stains of silver nitrate?

By applying a solution of potassium cyanid.

Should you prescribe powders or salol with camphor?

No, because these drugs liquefy when triturated together.

Would you write for potassium chlorate and tannin in the same prescription? Give reason for your answer.

No. Tannin precipitates potassium chlorate.

How should poisoning by coal-gas be treated?

The source of the poisonous gas should be sought and removed if possible. Fresh air should be admitted freely and oxygen administered to displace the carbon dioxid in the blood. Bodily heat is to be maintained, exertion avoided, artificial respiration resorted to. Cardiac respiratory stimulants, such as caffein, camphor, digitalis, and strychnin, are indicated. Venesection, followed immediately by intravenous infusion of physiologic saline solution, should be tried in grave cases.

Define galactagogue and sialagogue and give an example of each.

A galactagogue is a substance which increases the secretion of milk. *Example:* pilocarpin.

A sialagogue is a substance which increases the secretion of saliva. *Examples:* pilocarpin, mercury, the iodids.

Give an example of (a) topical sialagogue, (b) general sialagogue.

(a) Mustard and ginger.
(b) Pilocarpin and the iodids.

What are the three principal vegetable emmenagogues?

Ergot, cotton-root bark, and apiol.

Mention three vegetable emmenagogues and state the dose of each.

Cotton-root bark; the dose of the fluidextract is ½ to 1 dr. Ergot; the dose of the fluidextract is ½ to 2 dr. Apiol, dose, 2 to 8 min.

Name a vesicant derived from (a) the animal kingdom, (b) the vegetable kingdom, (c) the mineral kingdom.

(a) Cantharides; (b) mustard; (c) tartar emetic.

Describe two escharotics and tell how you would apply them.

Nitric acid. The chemically pure acid should be employed. The surrounding healthy skin should be protected by oil and, if the action of the acid becomes excessive, it should at once be neutralized with sodium bicarbonate.

Potassium hydrate. It is employed in stick form; the surrounding healthy skin is to be protected by oil and, if the action becomes excessive, the alkali should be neutralized with dilute acetic acid.

Describe hypnotics and the two classes into which they may be divided. Give examples.

Hypnotics are agents used to produce sleep. They may be divided into those which relieve insomnia when due to pain, and those which have no influence over pain, relieving insomnia when due to nervousness and allied conditions.

Name four efficient hypnotics and give the source and dose of each.

Chloral hydrate, prepared by the action of chlorin gas upon alcohol, dose, 5 to 20 gr. *Hyoscin*, an alkaloid derived from hyoscyamus, dose, $\frac{1}{150}$ to $\frac{1}{50}$ gr. *Sulphonal*, prepared from ethyl mercaptan, acetone, and potassium permanganate, dose, 5 to 30 gr. *Morphin*, an alkaloid of opium, dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr.

Name the hypnotic drugs and their doses, and name the chief hypnotic to be avoided if the patient has a weak heart, and tell why it should be avoided.

Morphin	dose	$\frac{1}{8}$ to $\frac{1}{2}$ gr.
Hyoscin	"	$\frac{1}{150}$ to $\frac{1}{50}$ "
Sulphonal	"	15 to 30 "
Trional	"	15 to 30 "
Tetronal	"	15 to 30 "
Veronal	"	5 to 20 "
Chloral hydrate	"	5 to 20 "

Chloral is to be avoided if the patient has a weak heart, as it is a cardiac depressant.

Name two respiratory stimulants and two vasomotor depressants; give the indications for the use of each, the dose and method of administration.

Atropin and *caffein* are valuable respiratory stimulants. They are administered by hypodermic injection or by the mouth. Caffein is also used in the form of strong black coffee. They are indicated in all conditions in which respiratory failure is present, such as poisoning by narcotic drugs, especially opium. The dose of atropin is $\frac{1}{150}$ to $\frac{1}{75}$ gr.; caffein, 2 to 5 gr.

Amyl nitrite and *nitroglycerin* are vasomotor depressants. Amyl nitrite is administered by inhalation; nitroglycerin by hypodermic injection or by the mouth. They are indicated in conditions of spasm with high arterial tension. The dose of amyl nitrite is 3 to 5 min.; that of spirit of nitroglycerin, 1 min., gradually increased.

Name the excitomotors.

Belladonna, hyoscyamus, digitalis, nux vomica, ergot, stramonium, caffein, convallaria, and suprarenal gland.

Describe vasomotor depressants, with an example.

Vasomotor depressants are drugs which decrease arterial pressure by their action on the vasomotor nervous system. They depress either the vasomotor center or the peripheral ends of the vasomotor nerves, or both. *Example:* amyl nitrite.

Name a vasomotor stimulant and vasomotor depressant, and describe the physiologic action of each.

Nux vomica is a vasomotor stimulant, acting on the vasomotor center. It stimulates the motor tracts of the spinal cord, the receptive activity of the sensory centers, reflex activity, and in poisonous doses produces tetanic convulsions. The frequency and force of the pulse are increased by stimulation of the heart muscle and its ganglia; the respiratory rate and vital capacity, by stimulation of the respiratory center.

Aconite is a vasomotor depressant, acting on the vasomotor center. It slows the pulse and lowers the arterial tension by depressing the heart muscle and stimulating the vagus center. The fall of arterial pressure is also due in part to depression of the vasomotor center. Aconite depresses the functional activity of the perceptive centers in the brain, the sensory side of the spinal cord, and the peripheral sensory nerves. The respiratory center is also depressed. Febrile temperatures are reduced by causing increased elimination of heat. The excretion of urine is augmented.

Name the two most active vasomotor stimulants, the most active respiratory stimulants, and state how they are useful in shock.

Atropin and *strychnin* are probably the two most active vasomotor stimulants. They are especially valuable in shock because they contract the arteries, restoring the vascular tone and preventing the blood from draining into the great capillary areas.

The most active respiratory stimulants are *atropin*, *strychnin*, and *caffein*. They are of service in shock to stimulate the respiratory center, which is depressed.

Name two arterial sedatives and state in what condition they should be given. Give dose of same for child of one year.

Aconite and *veratrum*. They are useful in the early stages of acute inflammation.

The *dose* of tincture of aconite for a child one year old is $\frac{1}{4}$ min. every hour; that of tincture of veratrum, $\frac{1}{2}$ min. every hour.

Describe and give the indications for the uses of cardiac sedatives, with an example.

Cardiac sedatives are drugs which are employed to diminish circulatory activity. They are indicated in the early stages of acute inflammation, especially when of the sthenic or dynamic type. For this purpose they are useful in croup, tonsillitis, pharyngitis, coryza, bronchitis, pericarditis, and sthenic pneumonia. They are also valuable in nervous palpitation of the heart and in the palpitation of excessive cardiac hypertrophy. *Aconite* is a valuable cardiac sedative.

State the name and the dose of each of two cardiac stimulants.

Digitalis, dose of the tincture, 5 to 20 min.

Strychnin, dose of the sulfate, $\frac{1}{60}$ to $\frac{1}{20}$ gr.

Define diaphoresis. Mention three diaphoretics and state the dose of each.

Diaphoresis is the production of perspiration. *Pilocarpus*, dose of pilocarpin hydrochlorid, $\frac{1}{10}$ gr. *Dover's powder*, dose, 2 to 10 gr. *Sweet spirit of niter*, dose, $\frac{1}{2}$ to 2 dr.

For what purpose is diaphoresis produced? Name three diaphoretics.

Diaphoresis is of value to arrest or mitigate beginning inflammations, to promote the absorption of effusions or transudates, to lower body-temperature, to increase the elimination of toxic material from the blood, and to diminish the work of the kidneys. Three valuable diaphoretics are pilocarpus, sweet spirit of niter, and Dover's powder.

For what purpose are diuretics employed?

Diuretics are employed to increase the quantity of urine excreted (increased elimination of toxic material), to dilute the urine, to alter its reaction, and to render it aseptic or antiseptic and non-irritating.

Describe four diuretics and give the dose of each.

Potassium acetate is a neutral, white salt of saline taste, readily deliquescent and soluble in water. It is a refrigerant diuretic and renders the urine alkaline. *Dose:* 10 to 60 gr.

Caffein is a feebly basic proximate principle, obtained from tea leaves or coffee. It is a stimulating diuretic, increasing both the liquids and the solids of the urine. *Dose:* 1 to 5 gr.

Digitalis, the leaves of *digitalis purpurea*, obtained from plants of the second year growth. It acts as a diuretic chiefly by raising the blood-pressure in the renal vessels and relieving stasis. It increases chiefly the watery elements of the urine. Dose of the tincture, 5 to 15 min.

Potassium bitartrate is a white, gritty powder which may occur in rhombic crystals. It is stated to be the most active diuretic of the potassium salts. *Dose:* $\frac{1}{2}$ to 4 dr.

Name the coal-tar products used to reduce temperature.

Those most commonly employed are acetanilid, antipyrin, and acetphenetidin (phenacetin).

By what methods do antipyretics act? Give an example of one that acts by each method.

Antipyretics reduce the temperature by diminishing heat production, increasing heat elimination, or both. Acetanilid and antipyrin act by diminishing the production of heat and increasing heat dissipation. Heat production is the function most affected. Aconite acts through increased heat radiation, resulting from vascular relaxation and impaired circulation. The cold bath acts by abstracting heat.

What are antipyretics? Describe their general uses and state how they are administered.

Antipyretics are agents employed to reduce body temperature. The coal-tar derivatives, such as acetanilid and antipyrin, are administered by

the mouth in doses varying from 2 to 10 gr. They are occasionally useful in sthenic fevers, but should not be employed in asthenic or adynamic fevers. They have been largely supplanted by cold water. Cold water not only reduces the temperature, but stimulates the general circulation through the vasomotor and nervous systems, as well as the processes of oxidation and nutrition, and aids in the elimination of effete material. It is employed in the form of sponging, the plunge bath, etc.

Define anthelmintics and name the remedies of this class.

Anthelmintics are remedies which are employed to remove intestinal worms.

For the removal of the round worm and tape-worm the following drugs are employed—aspidium (male fern), santonin, spigelia, chenopodium, and thymol.

Thread-worms and seat-worms are usually attacked by rectal injections of quassia, salicylic acid, tannic acid, vinegar, or turpentine.

Mention three emetics. State the dose of a preparation of each.

Zinc sulfate, dose, 5 to 10 gr.; mustard, dose, 1 to 4 dr.; apomorphin, dose, $\frac{1}{10}$ gr. hypodermically.

Describe two safe and efficient emetics for a child, and give dose for a child two years old.

Mustard, $\frac{1}{2}$ to 1 dr.; syrup of ipecac, 1 dr.

Name five emetics and give the dose of each.

Zinc sulfate, dose, 10 to 20 gr.; tartar emetic, dose, $\frac{1}{4}$ to 1 gr.; alum, dose, $\frac{1}{2}$ to 4 dr.; syrup of ipecac, dose, 1 to 4 dr.; apomorphin, dose, $\frac{1}{10}$ gr. hypodermically.

Define a laxative, a saline purgative, a drastic purgative, a hydragogue purgative, and a cholagogue purgative, with an example of each.

Laxatives are drugs which produce moderate stimulation of peristalsis, as cascara sagrada.

Saline purgatives produce free watery evacuations by abstracting water from the intestinal blood-vessels, as magnesium sulfate.

Drastic purgatives are violent in their action, producing large watery evacuations often attended with griping and tenesmus, as gamboge.

Hydragogue purgatives are drugs which produce free watery evacuation, such as jalap and elaterin.

Cholagogue purgatives are drugs which not only markedly stimulate peristalsis, but also stimulate the liver to greater activity, as podophyllin.

Give the physiologic action and therapy of saline purgatives.

All strong saline solutions above the strength of 7 per 1000 abstract liquids from the tissues when brought in contact with them. The salines thus act as purgatives by abstracting water from the intestinal vessels. They are useful to secure depletion of the intestines, to aid in the elimination of toxic

material, and to promote the absorption of exudates and transudates. They are preferably given in concentrated forms and on an empty stomach, before breakfast. They are employed in dropsy, enteritis, tropical dysentery, and in all cases in which depletion of the intestines and increased elimination of toxic material are desirable.

Mention (a) a hydrogogue, (b) a cholagogue purgative. State the dose of each.

Elaterin, dose, $\frac{1}{30}$ to $\frac{1}{16}$ gr.; podophyllin, dose, $\frac{1}{20}$ to $\frac{1}{2}$ gr.

Name three general anodynes and give the dose of some official preparation of each.

Opium, hyoscyamus, and cannabis indica. Morphin sulfate: dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr.; hyoscin hydrobromid: dose, $\frac{1}{150}$ to $\frac{1}{75}$ gr.; extract of cannabis indica: dose, $\frac{1}{4}$ to $\frac{1}{2}$ gr.

How do styptics and hemostatics differ? Give an example of each.

Styptics are agents which arrest bleeding when locally applied, such as tannic acid and alum. *Hemostatics* are agents which arrest bleeding when administered internally, such as ergot and nitroglycerin.

Name five vegetable and three mineral astringents, describing method of administration and dose in each instance.

Hematoxylon, kino, catechu, krameria, and geranium.

Hematoxylon is usually administered as the fluidextract in doses of $\frac{1}{2}$ to 2 dr. Kino, catechu, krameria, and geranium may be administered as the tincture of these drugs, in the dose of $\frac{1}{2}$ to 2 dr.

Three *mineral astringents* are sulfuric acid, lead acetate, and silver nitrate.

Sulfuric acid may be administered as the aromatic acid in the dose of 5 to 20 min. Lead acetate is given in pill form, dose, $\frac{1}{4}$ to 2 gr.; silver nitrate in pill form, dose, $\frac{1}{6}$ to $\frac{1}{4}$ gr.

What is the usual physiologic action of an astringent administered internally?

When astringents are administered internally, their action is usually confined to the mucous membrane with which they come in contact. They cause contraction of the blood-vessels, blanching, and diminution or arrest of secretions.

Name and describe three antiseptics useful for internal medication.

Salol is a white, crystalline powder, faintly aromatic and almost without taste. It is decomposed in the small intestine, in the presence of an alkaline reaction, into salicylic acid and phenol, thus acting as an antiseptic. *Guaiacol carbonate* is a white, crystalline powder, neutral in reaction, and insoluble in water. It is decomposed in the intestines into guaiacol and carbonic acid, acting as an efficient antiseptic. *Naphthol* is a white, crystalline powder employed as an intestinal antiseptic.

Define an antiseptic agent and mention three which are commonly used.

An antiseptic agent is one which destroys micro-organisms or inhibits their growth. *Examples:* Corrosive sublimate, hydrogen dioxid, and phenol.

Name two important intestinal antiseptics, the diseases in which they are indicated, and explain how they are used.

Salol and guaiacol carbonate.

Salol is valuable in intestinal indigestion and diarrhea due to fermentation, cholera, typhoid fever, cholera morbus, catarrhal jaundice, gonorrhea, and as an antirheumatic. It is best administered in capsules, one to two hours after meals. In the presence of the alkaline juice of the small intestine it is decomposed into phenol and salicylic acid.

Guaiacol carbonate is indicated in fermentative diarrhea and enteric fever to prevent putrefaction in the bowels, and in tuberculosis. It is decomposed in the small intestine into guaiacol and phenol. It is best administered in capsules in doses of 2 to 10 gr. one to two hours after food.

Name five antiseptics and tell in what proportions each should be diluted for surgical purposes.

Bichlorid of mercury in solutions varying in strength from 1 to 10,000 to 1 to 1000. Phenol, 1 to 40 to 1 to 20. Formalin (40-per cent. solution of formaldehyd gas in water), 1 to 8000 to 12,000. Potassium permanganate in solutions varying in strength from 1 to 500 to saturation. Boric acid in saturated solution, used in ophthalmology.

Name three drugs belonging to each of the following classes: narcotics, diaphoretics, ecbolics.

Narcotics: opium, belladonna, and cannabis indica.

Diaphoretics: pilocarpus, ipecac, and ammonium acetate.

Ecbolics: ergot, quinin, and savin.

Define narcotics, anesthetics, and sedatives, and give an example of each.

Narcotics are substances which produce sleep, allay pain, and in large doses depress the functions of respiration and circulation. *Example:* opium.

General anesthetics are drugs which produce total loss of consciousness, so that pain is no longer felt and reflex action is abolished. *Example:* ether.

Local anesthetics are substances which, when locally applied, diminish or abolish sensation. *Example:* cocain.

Sedatives are drugs which depress protoplasm and lower functional activity. *Example:* bromids.

Name four different classes of medicines, with an example of each class. Give dose of example.

(1) *Expectorants:* ammonium chlorid, dose, 2 to 10 gr.

(2) *Diaphoretics:* pilocarpus, dose of pilocarpin hydrochlorid, $\frac{1}{10}$ to $\frac{1}{4}$ gr.

(3) *Antispasmodics:* amyl nitrite, dose, 3 to 5 min. by inhalation.

(4) *Diuretics:* caffein, dose, 2 to 4 gr.

State the name and dose of a drug belonging to each of the following classes: (a) emetics, (b) diuretics, (c) diaphoretics, and (d) cathartics.

(a) Apomorphin, dose, $\frac{1}{10}$ gr. hypodermically; (b) potassium acetate, dose, 10 to 60 gr.; (c) pilocarpin hydrochlorid, dose, $\frac{1}{10}$ to $\frac{1}{4}$ gr.; (d) magnesium sulphate, dose, 1 to 8 dr.

Name the official vegetable acids.

Acetic (in three strengths), benzoic, salicylic, camphoric, gallic, hydrocyanic, tannic, and tartaric acid.

Name the mineral acids and mention the special properties of each.

Boric, dilute hydriodic, dilute hydrobromic, hydrochloric, dilute hydrochloric, hypophosphoric, dilute hypophosphoric, nitric, dilute nitric, nitrohydrochloric, dilute nitrohydrochloric, phosphoric, dilute phosphoric, concentrated, dilute, and aromatic sulfuric, and sulfurous acid.

Boric acid is valuable as a mild antiseptic, as a lotion to inflamed mucous membranes, and as a dusting-powder. Hydriodic acid is employed for its alterative influence; hydrobromic acid for its sedative effect; hydrochloric acid as an aid to digestion. Nitric acid is used externally as a caustic, internally as a tonic and astringent. Nitrohydrochloric acid is used especially as a cholagogue; phosphoric acid as an aid to digestion; aromatic sulfuric acid as an astringent. Hypophosphoric and sulfuric acids are rarely employed in medicine.

Name the mineral tonics.

Arsenic, iron, manganese, phosphorus, copper, mercury in small doses, and the mineral acids.

Name three animal oils, three vegetable oils, and source of each.

Animal oils are lard oil from the hog, cod-liver oil from codfish, sperm oil from the whale.

Vegetable oils are olive oil from olives, linseed oil from flaxseed, turpentine oil from the pine tree.

Name the official bromids.

Potassium, sodium, lithium, ammonium, strontium, and zinc bromids.

Mention a soluble salt of lead. To what therapeutic class does bismuth subnitrate belong?

Lead acetate. Bismuth subnitrate belongs to the class of sedative astringents.

Define germicides, parasiticides.

Germicides are agents which destroy micro-organisms. Parasiticides are agents which destroy parasites.

Explain how antitoxin causes immunity and effects cure and the methods of administration as a prophylactic and curative agent.

The antitoxin molecules are supposed to be the cast-off receptors of the cells, resulting from the union of the receptors with the toxophores of the toxin molecule. When the antitoxin molecules are free in the circulation, they combine with the toxin and prevent them from uniting with the body cells, thus producing immunity and effecting cure.

In *diphtheria*, antitoxin is administered hypodermically as a prophylactic agent to those exposed to the infection, before the development of symptoms, in doses of 1000 to 3000 units. As a curative agent it is administered in doses varying from 3000 to 10,000 units, according to the location of the membrane and severity of the symptoms. *Tetanus* antitoxin is employed hypodermically, intraneurally into the nerve leading from the infected area, and by injection into the spinal canal after withdrawing a small quantity of fluid.

What therapeutic uses has chloroform other than as an anesthetic?

Chloroform is employed internally as a carminative in gastric and intestinal flatulence with *colic*, in serous *diarrhea*, and to allay *cough*. By inhalation it is useful in renal and hepatic colic. Deep injections reaching to the nerve are useful in *sciatica*. Externally it is used as a counterirritant and local anesthetic in muscular rheumatism, lumbago, gout, and neuralgia.

Is ether ever used as a cardiac stimulant?

Ether is employed as a rapidly acting, diffusible cardiac stimulant in cases when quick action is desired.

What are the advantages in the use of chloroform as an anesthetic, and what are the signs indicative of danger in the patient?

Chloroform is advantageous on account of its agreeable odor, the rapidity of its action, the small amount necessary to produce anesthesia, and the diminished tendency to postoperative vomiting. It is preferable to ether in Bright's disease, bronchitis, aneurysm or atheroma of the blood-vessels, when large numbers of persons are to be anesthetized, in the performance of tracheotomy, in brain surgery, and during labor. The chief disadvantage of chloroform is its greater liability to produce death by heart failure.

Signs indicative of danger are irregular, shallow, or stertorous breathing, sudden dilatation of pupils following contraction, and signs of cardiac failure, with a marked fall in the blood-pressure.

Describe the composition of nitrous oxid. In case dangerous results follow its use, what means would you employ to combat them?

Nitrous oxid, chemically, is nitrogen monoxid, N_2O_2. If dangerous symptoms arise during its administration, the inhalation must be stopped, fresh air admitted, artificial respiration with rhythmic traction on the tongue performed, and cardiac and respiratory stimulants administered if necessary.

Name four contraindications for general anesthesia, and state which of the four named you would consider the most important.

Diabetes, advanced Bright's disease, fatty heart, pulmonary tuberculosis. *Diabetes* is probably the most important on account of the great danger of the development of fatal coma.

Define a general anesthetic. Mention three general anesthetics in common use.

A general anesthetic is a drug which produces total unconsciousness, loss of sensation and motor power, with abolition of the reflexes. Ether, chloroform, and nitrous oxid.

Name the ten drugs you most frequently employ and give the dose of each.

Atropin sulfate	dose	$\frac{1}{200}$ to $\frac{1}{75}$ gr.
Strychnin sulfate	"	$\frac{1}{60}$ to $\frac{1}{20}$ gr.
Tincture of digitalis	"	5 to 20 min.
Calomel	"	$\frac{1}{10}$ to 10 gr.
Magnesium sulfate	"	1 to 8 dr.
Arsenic (arsenic trioxid)	"	$\frac{1}{60}$ to $\frac{1}{30}$ gr.
Sodium salicylate	"	5 to 15 gr.
Acetphenetidin	"	2 to 10 gr.
Nitrohydrochloric acid	"	1 to 5 min.
Sodium bromid	"	5 to 30 gr.

What is cumulative action? Name one drug that has this tendency and give symptoms of such action.

When a drug is administered repeatedly in small doses for some time, symptoms may appear suddenly which are more marked than those produced by a single dose. The action is due either to actual accumulation of the drug in the organs of the body because absorption is more active than excretion, or to a "summation of a prolonged series of effects of the same kind."

Digitalis is the classic example. The explosion may be preceded by suppression of urine. Symptoms of poisoning develop; the pulse is at first slow and full, then becomes rapid and irregular; the cardiac action is tumultuous; headache is often a severe symptom, and there may be vomiting; exophthalmos and pearliness of the scleræ have been observed.

Explain the distinction between physiologic action and the therapeutic use of medicinal agents.

Physiologic action: The effect of the drug in normal doses on the nervous, respiratory, circulatory, and muscular systems, and on nutrition and metabolism in health, or as determined by animal experimentation.

Therapeutic use: The employment of the drug in disease according to indications based on the known physiologic action, or on experience (empiric use of drugs).

Mention three commonly used miotics.

Eserin, opium, and pilocarpin.

Define a mydriatic. Give three examples, with the dose for the local application in each case.

Mydriatics are drugs which produce dilatation of the pupil.

Atropin sulfate: dose, one or two drops by instillation of a solution containing 4 gr. to the fluidounce. *Homatropin hydrochlorate:* solution of 8 gr. to the fluidounce, one drop is instilled every ten minutes for an hour. *Duboisin sulfate:* 2 gr. to the fluidounce, one to two drops.

Name the therapeutic uses of carbolic acid except as an antiseptic.

Externally, carbolic acid or phenol in concentrated form is a caustic and local anesthetic. It is used chiefly in skin diseases to relieve itching, and may be employed in minor operations, such as eversion of ingrowing nails and opening a boil or felon. It is sometimes *injected* into enlarged glands to prevent suppuration, and to abort boils and felons. *Locally,* it is employed in diphtheria, stomatitis, and tonsillitis. As a spray it is useful in gangrene and tuberculosis of the lungs. *Internally,* it is serviceable in gastric irritation, vomiting, and diarrhea due to fermentation.

Upon what does the activity of hydrogen dioxid depend? How is it employed in medicine?

Its activity depends upon the nascent oxygen evolved. It is employed locally in follicular tonsillitis and diphtheria, for cleansing abscess cavities, ulcers, and malignant growths. It is also said to be of value for the removal of powder stains and adhesive strips, and as a remedy for the hornet's sting.

What is the physiologic effect of cocain on the ocular conjunctiva, the pupil of the eye, and the salivary and sweat-glands?

Cocain contracts the capillaries and paralyzes the peripheral ends of the sensory nerves of the ocular conjunctiva. It *dilates the pupil,* by stimulating the peripheral ends of the sympathetic nerve. It diminishes the secretion of the salivary and sweat-glands.

What is the important alkaloid of erythroxylon and what is its principal therapeutic use?

Cocain. Its principal therapeutic use is that of a local anesthetic.

Indicate the manner in which ethylic ether (sulfuric ether) should be applied to produce general anesthesia.

The patient should be properly prepared by emptying the alimentary tract, prohibiting food for twelve hours before the operation. Immediately before the anesthetization the mouth should be cleansed and false teeth and all other foreign substances removed. The head is to be kept low, and bodily heat maintained by covering the patient with blankets and avoiding unnecessary exposure. The ether may be administered by means of a gauze pad, a cone improvised from a towel and piece of paper, in the end of which a sponge is placed, or by means of an Allis inhaler. The inhaler is to be placed on the face gently and gradually, so as to avoid fright and struggling, and the ether is poured on drop by drop. The simultaneous administration of oxygen is often advantageous, or the anesthesia may be

begun with ethyl chlorid or nitrous oxid. The size of the pupil, sensibility of the conjunctiva, respiration, and especially the action of the diaphragm are to be closely watched. The first stage is marked by excitement and the patient may struggle violently; this is soon followed by a stage of quiescence, with contraction of the pupil, loss of the conjunctival and other reflexes, and muscular relaxation.

How would you distinguish chemically between ether and chloroform?

Chloroform is trichlormethane, $CHCl_3$. It is not inflammable, but is decomposed by an open flame, with the liberation of chlorin and hydrochloric acid.

Ether is ethyl oxid, $(C_2H_5)_2O$. It is very volatile and highly inflammable.

An anesthetic being indicated, state the conditions that render ether preferable and those that render chloroform preferable.

Chloroform is preferable to ether in cases of Bright's disease, aneurysm, or great atheroma of the blood-vessels, bronchitis, when large numbers are to be anesthetized, where an idiosyncrasy to ether exists, in the performance of tracheotomy, and in brain surgery.

Ether is preferred to chloroform in cases of fatty heart, dilatation of the heart, valvular disease of the heart, where an idiosyncrasy to chloroform exists, and in lymphatic persons with overgrowth of lymphoid tissue.

What is the therapeutic action of creosote, mode of action, and dose?

Creosote in its action resembles phenol. In medicinal doses it exerts but little influence on the *nervous system;* in toxic doses it causes depression, stupor, and convulsions. *Locally applied*, it paralyzes the peripheral sensory nerves, and in concentrated form is a superficial caustic.

Upon the *circulation* small medicinal doses have no influence; toxic doses are depressant.

The *respiration* becomes more rapid and full under the influence of large doses, owing to stimulation of the respiratory center and peripheral endings of the pneumogastrics; toxic doses kill by failure of respiration.

Febrile temperatures are lowered by diminishing heat production and increasing heat elimination. Large doses cause renal irritation and perhaps suppression of urine. It is efficient as an antiseptic and as a stimulating expectorant.

Dose: 2 to 5 min.

Briefly give therapeutic indications for creosote and guaiacol. In what conditions would guaiacol be superior to creosote?

Creosote and guaiacol are useful in chronic bronchitis, phthisis, subacute laryngitis, whooping-cough, indigestion with fermentative change in the gastric contents, and *locally* for the relief of toothache. Guaiacol is superior to creosote as an intestinal antiseptic, being employed for the purpose in fermentative diarrhea and typhoid fever.

What are the therapeutic uses of sulfur?

Externally, it is employed in skin diseases of a subacute and chronic character, such as eczema and acne, and as a parasiticide in the treatment of scabies. *Internally*, it is useful as a laxative, in chronic rheumatism, in sciatica, and for catarrhal conditions of mucous membranes, such as subacute and chronic bronchitis, gastritis, and enteritis.

What injury may result from large doses or the long-continued use of potassium chlorate?

Large doses, or the long-continued use of potassium chlorate in normal dosage, may cause crenation and destruction of red blood-cells. The blood becomes chocolate colored (production of methemoglobin). The kidneys are irritated and acute nephritis may result.

What are the medicinal uses of potassium chlorate?

Potassium chlorate is applied locally and administered internally in stomatitis, acute follicular pharyngitis, and diphtheria. As rectal injection in starch water it is useful in acute rectal catarrh and hemorrhoids.

Give the source and state the uses of thymol.

Thymol is a phenol derived from the volatile oils of Thymus vulgaris. *Externally*, thymol is employed as an antiseptic dressing for wounds. *Internally*, it is employed as an intestinal antiseptic in enteric fever and for the removal of intestinal parasites. It is applied *locally* in stomatitis, tenderness of the gums, and catarrhal conditions of the nose and rhinopharynx.

What are the therapeutic uses and the preparations of borax?

Borax is applied *locally* as a wash in the treatment of aphthous stomatitis, cancrum oris, diphtheria, catarrhal condition of the nose and rhinopharynx, erysipelas, burns, scalds, pruritus ani and vulvæ, and bromidrosis. *Internally*, it has been recommended in epilepsy.

Mention the therapeutic uses of ergot of rye. What is the dose of the fluidextract of ergot?

Ergot is employed for the prevention and arrest of postpartum hemorrhage and for overcoming subinvolution of the uterus. It is also of value in menorrhagia, metrorrhagia, epistaxis, night-sweats, dysentery, serous diarrhea, bleeding hemorrhoids, uterine fibroids, and diabetes insipidus.

Dose of the fluidextract, ½ to 2 dr.

Give the physiologic action of ergot and mention its therapeutic uses.

Ergot produces tonic contraction of the uterus by stimulating the smooth muscle-fibers and the uterine centers in the lumbar portion of the spinal cord. It is a general stimulant to all unstriped muscle-fibers. It raises arterial tension by stimulating both the vasomotor center and the muscular coats of the blood-vessels. It is also a hemostatic, antihydrotic, emmenagogue, and oxytocic. (For therapeutic uses see preceding question.)

Give the physiologic action of ergot and name the conditions that indicate its use in labor and the contraindications.

See previous question.

Ergot is indicated during labor in some cases of uterine inertia. After the child is born, it is valuable for insuring uterine contraction and preventing or arresting postpartum hemorrhage and for overcoming subinvolution of the uterus. It is contraindicated if the birth canal is obstructed or the os is not well dilated, and should be used with care if clots or placental fragments are retained, as spasm of the os may prevent their escape.

Give the common name and therapeutic uses of hematoxylon.

Logwood. It contains an active principle, hematoxylin, but its activity depends upon the tannin. It is a mild astringent and is employed chiefly in serous diarrhea; occasionally in leukorrhea.

In what condition is gallic acid useful?

Gallic acid is useful in hematuria, hemoptysis, metrorrhagia and menorrhagia; colliquative sweats; chronic bronchitis with profuse expectoration; acute and chronic diarrhea; albuminuria due to relaxed and torpid kidneys, and, combined with opium, in diabetes mellitus and insipidus. *Externally*, it is useful in psoriasis, ulcers and sores, and external hemorrhoids.

What are the uses of lactic acid in medical practice and what pathologic conditions may its administration produce?

Lactic acid is employed *internally* in indigestion, green diarrhea of children, tuberculous diarrhea, phosphatic deposits in the urine, and diabetes. *Locally*, it has been applied to diphtheritic membrane and to tuberculous ulcers in the larynx. *Externally*, it is of value for the removal of freckles and chloasma. Lactic acid is said to produce rheumatism when administered in excess.

What is the common name of staphisagria? What are the therapeutic uses of staphisagria?

Stavesacre, larkspur. It is an emetic and cathartic, but is not employed for these purposes. It is employed *externally* as a *parasiticide* (pediculosis capitis), as an embrocation for rheumatism, and occasionally in eczema.

What are the therapeutic uses of resorcin?

Resorcinol possesses analgesic, antiseptic, and hemostatic properties. It is employed *internally* in gastric ulcer. As a spray it is used in whooping-cough and asthma. *Externally*, it is useful in skin diseases of a subacute or chronic character, such as eczema and psoriasis.

To what chemical change does sulfur ointment owe its efficiency as a parasiticide?

To the formation of sulfids, which are parasiticides.

What are the principal therapeutic uses of the salts of lead?

Lead acetate is used as an astringent and hemostatic. It is employed in dysentery, serous diarrhea, gastric and intestinal hemorrhage, gonorrhea, and externally, in the dermatitis of ivy-poisoning.

The *subacetate* is employed chiefly externally in the treatment of sprains, bruises, local inflammations, pruritus, eczema, and for the dermatitis of ivy-poisoning.

Lead iodid, when employed at all, has the alterative effect of iodin.

Lead oxid is employed in the preparation of lead plaster and Goulard's extract.

Lead carbonate is used as a dressing for burns, scalds, ulcers, and sunburn.

Lead nitrate is used externally in onychia and epithelioma, and to promote the growth of healthy granulations.

What is the common name and therapeutic use of plumbi acetatis?

Sugar of lead. It is employed in serous diarrhea, dysentery, gastric and intestinal hemorrhage, gonorrhea, and externally for bruises, sprains, local inflammations, and the dermatitis of ivy-poisoning.

What are the therapeutic uses of the preparations of silver?

Silver nitrate is sedative, astringent, antiseptic, hemostatic, and, in concentrated form, a superficial caustic. It is employed *internally* in gastric ulcer, chronic gastritis, intestinal ulceration, posterior spinal sclerosis, epilepsy, and chorea; in colonic irrigations for ulcerations of the cecum and rectum, and in acute and chronic dysentery. *Locally*, it is used in stomatitis, tonsillitis, pharyngitis, laryngitis, conjunctivitis, granular lids, pruritus vulvæ and ani, uterine ulceration, leukorrhea, gonorrhea, boils and bed-sores. *Fused silver nitrate* is employed externally as a caustic. *Silver oxid* and *cyanid* are rarely employed in medicine.

Describe the therapeutic uses of zinc sulfate and of zinc oxid.

Zinc sulfate is employed chiefly as an astringent to mucous membranes in the treatment of gonorrhea, serous diarrheas, and conjunctivitis. It is also a useful peripheral emetic in cases of poisoning by narcotic drugs.

Zinc oxid in ointment or powder is employed externally in the treatment of skin diseases, burns, wounds, leg ulcers, and intertrigo. Internally, it has been employed for the relief of night-sweats, asthma, whooping-cough, and chorea.

What are the therapeutic uses of the preparations of zinc?

Zinc acetate is employed as an astringent to mucous membranes in the treatment of conjunctivitis and gonorrhea.

Precipitated zinc carbonate and *oxid* are employed externally in skin diseases of the moist variety, burns, wounds, leg ulcers, and intertrigo. The oxid is also used internally in the treatment of summer diarrhea, night-sweats of debility and phthisis, asthma, whooping-cough, and chorea.

Zinc chlorid is employed externally as a *caustic* in epitheliomata and similar conditions.

Zinc phenolsulfonate is employed as an intestinal antiseptic in the treatment of diarrhea, enteric fever, flatulence, and auto-intoxication.

Zinc stearate is used externally as a dusting-powder in intertrigo and similar conditions.

Zinc sulfate is an astringent to mucous membranes and is employed in serous diarrheas, gonorrhea, and conjunctivitis; it is also a valuable peripheral *emetic* in cases of poisoning by narcotic drugs.

Zinc valerate is employed as a nervous sedative in insomnia, hysteria, delirium tremens, and similar conditions.

Zinc phosphid is employed in nervous debility, impotence, rachitis, osteomalacia, and all conditions where phosphorus is indicated.

What are the therapeutic uses of the preparations of bismuth?

Bismuth subcarbonate and *subnitrate* exercise a mild astringent and protective influence upon mucous membranes. They are employed in acute gastritis, gastric ulcer, vomiting, gastralgia, dyspepsia, and serous diarrheas. Externally, they are useful in intertrigo and similar conditions.

Bismuth subsalicylate is especially valuable in the treatment of diarrhea due to fermentation or putrefaction.

Bismuth subgallate is chiefly employed externally in the treatment of skin diseases, such as moist eczema; it is also valuable in otitis media.

Bismuth benzoate is employed externally as a dressing for chancroids, specific sores, and indolent ulcers.

Name the official preparations of bismuth and give the dose of each.

Bismuthi citras	dose	1 to 5 gr.
Bismuthi et ammonii citras	"	1 to 5 "
Bismuthi subcarbonas	"	5 to 20 "
Bismuthi subgallas	"	5 to 10 "
Bismuthi subnitras	"	5 to 20 "
Bismuthi subsalicylas	"	3 to 15 "

What are the principal uses of chlorid of lime? To which ingredient does it owe its energy?

Calcium chlorid is employed internally in the treatment of scrofulous enlargement of the glands of the neck. In cases where deficient bone formation is present, in the treatment of boils, pruritus, and to *increase the coagulability* of the blood in hemophilia, urticaria, and hemorrhage. It owes its activity to the calcium contained.

What are the effects, uses, and doses of calcium chlorid?

See next question.

The dose is 5 to 30 gr.

In hemorrhage it should be used for a short time only, as its prolonged use diminishes the coagulability of the blood by exhausting the fibrin ferment.

What are the therapeutic uses of lime (calcium)?

Internally, lime is employed as *lime-water* in the treatment of nausea and vomiting; as an antacid; to prevent the too rapid coagulation of milk in the stomach and the formation of a hard curd. *Externally*, it is of value in tinea capitis and, mixed with linseed oil (Carron oil), it is extensively used in the treatment of burns. It has been used locally in the treatment of diphtheria and membranous croup. As an *escharotic* it may be applied to old indolent ulcers and hairy growths.

What are the medicinal uses of hydrastis?

Hydrastis is a useful remedy in the treatment of depraved mucous membranes. It is employed in chronic gastro-intestinal catarrh, catarrhal jaundice, chronic nasal inflammations, and as a local application in uterine catarrh, leukorrhea, and gonorrhea. As a hemostatic it is not to be depended upon.

Give the common name of hydrastis and describe its therapeutic uses.

Goldenseal. See previous question.

Name some of the indications and contraindications of ergot. To what alkaloid or active principle does it owe its therapeutic activity?

Ergot is indicated in menorrhagia, metrorrhagia, uterine subinvolution, and for the prevention and arrest of post-partum hemorrhage. It is also useful in epistaxis, night-sweats, dysentery, and serous diarrhea. Ergot is *contraindicated* when the birth canal is obstructed, and in the first and second stages of labor. Care should be exercised in its administration when clots or placental fragments are retained within the uterus. Pulmonary hemorrhage may be aggravated by its administration by raising the blood-pressure.

Cornutin and *sphacelinic acid* are believed to be the active principles of ergot.

Describe the physiologic action of alum. In what pathologic conditions is alum useful?

Alum is a powerful *astringent.* When applied to mucous membranes it causes whitening, constriction, and puckering; applied to the skin, it thickens and toughens it. It decreases secretion and causes contraction of the local blood-vessels and capillaries. Internally, it acts as an emetic. Alum is useful to arrest bleeding, when it can be applied directly to the bleeding point. It is also useful in diphtheria, follicular tonsillitis, ptyalism, pharyngitis, membranous croup, bronchorrhea, gastralgia, dysentery, and leukorrhea. Externally, it is used to control night-sweats in bromidrosis, pruritus, ulcers, and to harden the skin.

For what pathologic conditions is camphor used?

Camphor is employed as a nervous sedative and antispasmodic, as a carminative in intestinal flatulence, and as a fugacious cardiac stimulant. It is useful in cholera, cholera morbus, serous diarrhea, chordee, hiccup, capillary bronchitis, coryza, and headache due to nervous fatigue. As a cardiac stimulant it is administered hypodermically, dissolved in olive oil. It enters into the composition of liniments for the relief of inflammation due to sprains, contusions, myalgic pains, and acts as a mild analgesic when applied externally in neuralgia.

What is a physiologic action of camphor in medicinal doses on (a) the skin and (b) the circulation?

(a) Irritant and rubefacient. (b) Camphor stimulates the heart and probably depresses the vasomotor center, increasing the frequency of the pulse and lowering arterial tension.

Mention the preparations of ammonia. What effect has ammonia on the heart?

The official preparations are aqua ammoniæ, aqua ammoniæ fortior, linimentum ammoniæ, spiritus ammoniæ, and spiritus ammoniæ aromaticus. It increases the force and frequency of the heart by stimulating the cardiac muscle and the accelerator nerves.

What are the physiologic effects and medicinal uses of the preparations of belladonna?

The extract, fluidextract, and tincture of belladonna, its alkaloid, atropin, and its salts, are cardiac, vasomotor, and respiratory stimulants; stimulate intestinal peristalsis and allay excessive secretion. Instilled into the eye, atropin causes mydriasis and paralyzes the accommodation. To check excessive secretion the drug is employed in the night-sweats of phthisis, bromidrosis, ptyalism, serous diarrhea, and to arrest lactation; as cardiac and vasomotor stimulants in cardiac weakness, shock, collapse following operations or occurring during the course of acute infectious diseases; as antispasmodics in acute torticollis, spasm of the intestine, asthma, whooping-cough, spasm of the sphincter ani, spasm of urethra and bladder, hiccup, laryngismus stridulus, and spasmodic dysmenorrhea. For their intestinal action they are employed in constipation, usually with other remedies, as in the aloin, belladonna, and strychnin pill, to stimulate peristalsis, allay spasm, and prevent griping.

Externally, belladonna liniment, ointment, and plaster are employed as local anodynes in myalgia, neuralgia, and similar conditions.

Give the therapeutic uses of caffein.

Caffein is employed in cardiac and renal dropsies; as a cardiac stimulant during the course of acute infectious diseases; and in cases of renal insufficiency due to torpidity and chronic inflammation. In *headache* due to nerve strain caffein combined with antipyrins and the bromids is very valuable. It is a valuable antidote to poisoning by opium and is also of service in asthma.

Describe the therapeutic uses of spartein and state the dose of the sulfate for hypodermic uses.

Spartein is a cardiac stimulant and diuretic. It is employed in cardiac failure, arrhythmia, and palpitation. It has also been employed in paralysis agitans. The *dose* for hypodermic use is $\frac{1}{10}$ to $\frac{1}{2}$ gr. of the sulfate.

How do strophanthus and digitalis differ in physiologic action?

Digitalis stimulates the heart muscle, the vagi peripherally and centrally, the vasomotor center, and the muscular coats of the blood-vessels. *Strophanthus* stimulates the heart muscle, as does digitalis, but does not affect the vagi or vasomotor system; consequently it does not slow the pulse and raise arterial tension to the same degree. It is preferred to digitalis in the presence of high arterial tension, when digitalis fails, and in children.

What are the therapeutic uses of strophanthus? Mention the dose of the tincture of strophanthus.

Strophanthus is a valuable cardiac stimulant, being especially valuable when high arterial tension is present, in children, and when digitalis has failed. It is also recommended for the tachycardia of exophthalmic goiter. Tincture of strophanthus, 2 to 10 min.

For what conditions should (a) tincture of digitalis, and (b) infusion of digitalis be given? Mention the dose of each.

The *tincture* should be employed when its stimulating influence upon the heart is especially desired. The *infusion* is used chiefly for its diuretic effect. Tincture, 5 to 20 min.; infusion, 2 to 4 dr.

How do digitalis and belladonna act in increasing blood-pressure?

Digitalis increases blood-pressure by stimulating the heart muscle, the vasomotor center, and the muscular coats of the blood-vessels.

Belladonna increases blood-pressure by stimulating the heart muscle, the accelerator nerves, and the vasomotor center.

Where is the habitat and what are the physiologic effects of digitalis?

Habitat: Europe. It is cultivated in various parts of the world. Digitalis stimulates the heart muscle, its ganglia, increasing the force of the ventricular systole and the amount of blood which enters the aorta and coronary arteries. It thus *improves the nutrition of the heart muscle.* It stimulates the vagus centers and the peripheral vagi, *prolonging the diastole.* The vasomotor center and the muscular coats of the blood-vessels are also stimulated and the *blood-pressure is raised.* The *diuretic* action of the drug results from the increase in the amount of blood that passes through the kidneys, the rise of blood-pressure, and the relief of stasis.

Toxic doses decrease reflex activity by stimulating Setschenow's reflex inhibitory center and by depressing the spinal cord. Convulsions occasionally occur. Finally the motor nerve-trunks are depressed and the muscles paralyzed. Upon the respiration it has no influence in medicinal amounts. Toxic doses lessen the frequency. Toxic doses lower body temperature, high temperatures prevent the drug from acting.

What is the ultimate effect on the heart's action of medicinal doses of belladonna?

Belladonna may cause, temporarily, a diminution in cardiac frequency. This is soon replaced by *increased frequency and force* due to stimulation of the heart muscle and accelerator nerves, and by depression of the vagi.

What is the dose of tincture of belladonna and what indications show that its physiologic effect has been obtained?

Five to 15 min. When the physiologic effect is obtained, the pupils dilate, the face becomes flushed, the fauces red and dry, and the pulse rapid and wiry. An erythematous rash may appear and delirium sometimes occurs.

What is the dose of sulfate of atropin?

The dose of atropin sulfate is $\frac{1}{200}$ to $\frac{1}{50}$ gr.

What is the physiologic action of veratrum on the circulation?

It depresses the heart muscle and stimulates the pneumogastric nerves, thereby slowing the pulse. It depresses the vasomotor center, which with the cardiac depression *lowers the arterial tension.*

In what pathologic condition is veratrum useful?

Veratrum is useful in the early stage of acute, sthenic, or dynamic inflammations, such as pneumonia, pleurisy, peritonitis, acute hepatitis, and cerebritis. It also is useful in cardiac hypertrophy and aneurysm to lower arterial tension, and in eclampsia. Locally, it has been employed like aconite for relief of neuralgia.

Give the physiologic action of veratrum and aconite and name diseases in which they are useful, stating dose.

Aconite slows the pulse and *lowers arterial tension* by depressing the heart muscle and the vasomotor center, and by stimulating the vagus center. It depresses the functional activity of the sensory perceptive centers, the sensory side of the spinal cord, and the peripheral sensory nerves. It depresses the respiratory center. It lowers bodily temperature by increasing heat elimination; veratrum probably lowers temperature in the same manner. *Veratrum* and *aconite* are useful in the early stage of acute sthenic or dynamic inflammations, such as pneumonia, pleurisy, peritonitis, cerebritis, pericarditis, coryza, and bronchitis. They are also valuable in excessive cardiac hypertrophy and palpitation. Aconite is useful in vomiting and externally as a local anesthetic. Veratrum is especially useful in eclampsia. *Dose:* Tincture of aconite, 5 to 15 min.; tincture of veratrum, 3 to 6 min.

See also page 282.

Mention the conditions that contraindicate the administration of aconite.

Cardiac asthenia, cardiac degeneration or dilatation, and all conditions characterized by marked asthenia or adynamia.

(a) What are the therapeutic uses of nitroglycerin? (b) By what other names is nitroglycerin known?

(a) Nitroglycerin is employed in angina pectoris, to *lower arterial tension* in cardiac affections, arteriosclerosis, chronic parenchymatous and chronic interstitial nephritis. It is also useful in asthma, chorea, epilepsy, gastralgia, vomiting, and to prevent the untoward effects of morphin. (b) *Spiritus glycerylis nitratis*, spirit of glyceryl trinitrate, spirit of nitroglycerin; spirit of glonoin (unoff.). Prescribe *spiritus glycerylis nitratis;* dose: one drop.

Why is nitroglycerin a valuable remedy when administered in connection with digitalis in cases of gradual heart failure in the aged?

Aged persons usually suffer with arteriosclerosis and high arterial tension. One of the actions of digitalis being to increase the blood-pressure, this can be neutralized by combining nitroglycerin with it.

How is amyl nitrite administered, and for what purpose?

By inhalation. The perles, containing 3 to 5 min., are placed in a handkerchief and crushed between the fingers.

Amyl nitrite is a powerful antispasmodic and is useful in angina pectoris, the convulsions of strychnin poisoning, tetanus, puerperal eclampsia, and infantile convulsions. It is also of value in epilepsy, whooping-cough, laryngismus stridulus, asthma, spasmodic croup, and in certain cases of cardiac failure.

State the effect of amyl nitrite on the vascular system.

Amyl nitrite depresses the vagus centers and causes relaxation of the blood-vessels, increasing the pulse frequency and lowering the blood-pressure by depressing the vasomotor center and the muscular coats of the blood-vessels. In very small amounts it stimulates the heart muscle, but its dominant action is depressant.

What are the physical properties of amyl nitrite?

Amyl nitrite is a very volatile, somewhat oily liquid, possessing a peculiar fruit-like odor. It is made by the action of nitric and nitrous acids upon amylic alcohol.

Describe the medicinal uses of hydrocyanic acid.

Hydrocyanic acid is a sedative to the peripheral sensory nerves. It is employed in irritable stomach, nervous vomiting, gastralgia, enteralgia, irritable coughs, and externally in skin affections attended by itching.

Give the physiologic action of opium. Name its most important alkaloids and give dose of each.

Opium depresses the intellectual centers of the brain, *producing sleep*, and the perceptive center, thus *relieving pain*. Reflex activity is also diminished. Upon the *circulation* it has little influence, in small amounts. In full doses it increases the force and frequency of the pulse and raises arterial tension by stimulating the heart muscle and its ganglia, and the vagi centrally and peripherally. Upon the *respiration* small doses are probably stimulant; large ones powerfully *depress the respiratory center.* The body temperature is raised slightly by full doses and lowered by poisonous amounts. The pupils are contracted (*pin-point pupils*) by central stimulation of the oculomotor nerves. Opium depresses the motor activity of the stomach and intestines and produces *constipation* by stimulating the splanchnic inhibitory fibers in the intestine. All secretions except that of the skin are checked by opium. It is a conservative of the tissues of the body.

Morphin and its salts, dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr.; *codein* and its salts, dose, $\frac{1}{2}$ to 2 gr.

Compare the therapeutic values of the several preparations of opium and state the indications for their use.

Morphin and its salts are especially valuable for the relief of *pain*, insomnia due to pain, and for hypodermic use.

Codein and its salts are advantageous to allay *cough*, as they are less narcotizing, do not produce constipation, nor check secretion. They are also valuable in the treatment of *diabetes*.

Dover's powder is valuable for its *diaphoretic effect*.

Powdered opium and its preparations are especially valuable to check excessive secretion, as in serous *diarrhea*, and diabetes mellitus and insipidus.

Deodorized opium and the *deodorized tincture* are indicated in preference to the plain opium and its tincture, in cases where it is especially desirable to avoid disturbances of digestion and vomiting.

Paregoric is the weakest of the liquid preparations of opium, and is especially useful for children and for the relief of *diarrhea* because it contains a volatile oil and camphor.

Give therapeutic action of opium.

Opium is a nervous sedative, hypnotic, analgesic, antispasmodic, and diaphoretic. It checks excessive secretion, allays inflammation and irritation, and supports the system when subjected to great physical or nervous effort.

In what disease is opium used principally?

In diabetes, particularly diabetes mellitus, opium is used empirically.

Explain the constipating action of opium.

Opium produces constipation by checking the intestinal secretions and by stimulating the splanchnic inhibitory fibers, thereby preventing peristalsis.

Compare the action of morphin with that of atropin.

Morphin depresses the intellectual centers of the brain, producing sleep; it depresses the perceptive centers and thus relieves pain. It diminishes reflex activity. Atropin in full doses acts as a powerful excitant to the brain and may produce delirium. It depresses the peripheral sensory nerves, and, like opium, diminishes reflex activity. Small doses of morphin have no influence on the circulation, large ones slow the pulse, increase its force, and raise arterial pressure by stimulating the heart muscle and ganglia, and pneumogastric nerves centrally and peripherally. Belladonna quickens the pulse by depressing the vagi peripherally and by stimulating the heart muscle and accelerator nerve-fibers. It produces a rise of blood-pressure by stimulating the vasomotor center and by the increased cardiac action. Morphin depresses the respiratory center; atropin stimulates it. Morphin checks peristalsis by stimulating the splanchnic inhibitory fibers in the intestine; atropin increases peristalsis by depressing the peripheral ends of the inhibitory fiber of the splanchnic nerve and by diminishing spasm. Morphin checks all the secretion except that of the skin, which it increases; atropin checks all secretion except that of the urine, which it increases. Morphin contracts the pupil; atropin causes dilatation. Both, in full doses, are capable of raising the body temperature.

How is the action of opium modified by (a) age, (b) sex, (c) idiosyncrasy, and (d) habit?

(a) Children, as a rule, bear opium very badly.

(b) Males, as a rule, bear opium better than females.

(c) In those persons having an idiosyncrasy it may produce wakefulness, delirium, or mental depression, nausea, vomiting, itching of the skin, and an erythematous rash.

(d) Persons addicted to the opium habit often tolerate enormous doses.

What is the effect of full doses of opium on respiration and to what extent may this effect be safely carried in treatment?

As full doses of opium depress the respiratory center, the drug must be used cautiously, or not at all, when respiratory embarrassment is present, especially when edema of the lungs is threatened.

What is codein? State the dose of codein. What are the advantages of codein over opium?

Codein is an alkaloid derived from opium. *Dose:* $\frac{1}{2}$ to 2 gr. Codein has less narcotizing power than opium, does not arrest secretion in the respiratory and intestinal tracts, and is less apt to cause constipation and other untoward effects.

Why is atropin combined with morphin when the latter is administered? What is the dose of atropin when combined with morphin?

Atropin is the physiologic antagonist of opium and tends to prevent the circulatory depression, constipation, and other untoward effects of opium. *Dose,* when combined with morphin, $\frac{1}{150}$ to $\frac{1}{75}$ gr.

Name three indications for the use of opium.

To relieve pain, to induce sleep when wakefulness is due to pain, and to check excessive secretion.

What are the physiologic effects of gelsemium and what is the dose of the tincture?

Gelsemium depresses the sensory side of the spinal cord and ultimately the motor side. It acts as a depressant and paralyzant to the nerves and muscles of the head. It is a depressant to the circulation, acting chiefly on the heart; in large doses it paralyzes the vagus. Death results from paralysis of the respiratory center. The temperature is considerably lowered by toxic doses. Gelsemium causes mydriasis by paralyzing the motor oculi nerve peripherally.

The *dose* of the tincture is 5 to 10 min.

What are the therapeutic uses of gelsemium?

Gelsemium is employed in headache, migraine, asthma, whooping-cough, laryngismus stridulus, torticollis, spasmodic dysmenorrhea, and is a mydriatic. It has been employed in malarial fever, the early stages of pneumonia and pleurisy, and in nervous cough.

In what dose may sulfonal be administered to an adult to produce a soporific effect?

Ten to 30 gr. in hot milk. As the effects are slowly manifested, the drug should be given several hours before retiring.

State the effect of the bromids on the respiration and on the action of the heart. What effect is the long-continued use of the bromids liable to produce on the mental faculties?

In medicinal doses they do not affect the respiration, except when the amounts are large and are persistently administered. In toxic doses the bromids depress the respiratory center. Upon the circulation ordinary medicinal doses have no influence.

The prolonged use of the bromids impairs the intellectual faculties and causes the patient to become dull and stupid. Mental aberration may develop, the patient becoming irritable, morose, and even homicidal.

What are the uses of the bromids?

The bromids are used as nervous sedatives, in all conditions where overexcitement of nervous protoplasm is present. They are useful in epilepsy, hysteria, insomnia, headache, convulsions in children and adults, seminal emissions, nymphomania, incontinence of urine due to vesical spasm, acute laryngitis, whooping-cough, laryngismus stridulus, dysmenorrhea and menorrhagia, sea-sickness, and vomiting.

Describe the therapeutic uses of chloral hydrate.

Chloral is a valuable *hypnotic* when the insomnia is due to nervousness and not to pain. It is also a valuable antispasmodic.

It is employed in nervous insomnia, infantile convulsions, tetanus, and strychnin poisoning, uremic and puerperal convulsions, infantile colic, chorea, paralysis agitans, delirium tremens, hiccup, whooping-cough, and epilepsy.

How does a toxic dose of chloral hydrate affect the body temperature?

A toxic dose of chloral hydrate causes a marked fall in the body temperature, due partially to failure of circulation and vascular dilatation.

What is the physiologic action of Indian hemp?

In full doses *Cannabis indica* causes exhilaration and attacks of incessant laughter, or in other cases disagreeable sensations and often a feeling as of impending death. One of the most constant symptoms is the sensation of *prolongation of time*. Following these symptoms, deep sleep, often lasting for many hours, ensues. Upon mucous membranes the drug acts first as an irritant and then as a local anesthetic.

What are the therapeutic uses of cannabis and what is the dose of the tincture of cannabis indica?

Cannabis indica is employed as a *sedative*, as a *soporific*, and as an *analgesic*, especially when pain is due to nerve disturbance. It is useful in

migraine, to allay cough, in paralysis agitans, exophthalmic goiter, vesical spasm, sexual impotence, uterine subinvolution, metrorrhagia, nervous and spasmodic dysmenorrhea, gonorrhea, and to relieve pain in cases of internal cancer.

The *dose* of the tincture is 15 min. to 1 dr.

Describe the physiologic action of hyoscin and name a physiologic antidote.

Hyoscin is a *cerebral sedative*, acting as an efficient *hypnotic* in certain cases of insomnia. It depresses the spinal cord and causes a loss of reflex action. Full doses produce dryness of the mouth, flushing of the face, great sleepiness, and possibly a semi-delirious condition. The respirations are lessened in frequency and pulse frequency is diminished. Dropped into the eye, it produces mydriasis and paralysis of accommodation.

The physiologic antidote is *pilocarpin*.

Give the dose of hyoscin for hypodermic use. For what purpose is hyoscin used?

One-two hundredth to $\frac{1}{50}$ gr. of the hydrobromid.

It is chiefly employed as a hypnotic, when insomnia is due to acute mania, hysteria, delirium tremens, and similar conditions. It is also useful in spermatorrhea and nocturnal emissions.

Name the therapeutic uses of apomorphin and state how codein differs in its physiologic action from morphin.

Apomorphin is a rapidly acting *centric emetic*, used in cases of poisoning by depressant and narcotic drugs. In catarrh of the gastro-intestinal and respiratory tracts it is useful to expel mucus by emesis. In acute bronchitis, when secretion is scanty and cough excessive, it is quite useful, in *expectorant* doses. It is also used in non-emetic doses in delirium tremens.

Codein resembles morphin in its action, but has less narcotizing power. It does not arrest secretion in the respiratory and intestinal tract, as does morphin, and is less apt to cause constipation.

Give the medical name and the official preparations of lignum vitæ.

Guaiacum, tinctura guaiaci, tinctura guaiaci ammoniata.

Mention the salts of lithium and describe their medicinal uses.

The official salts of lithium are the benzoate, bromid, carbonate, salicylate, citrate, and effervescing citrate.

All the salts of lithium are employed for the acids, with the exception of the citrate and carbonate, which are employed for the lithium contained. They are indicated in *gout*, rheumatism, rheumatoid arthritis, and the uric-acid diathesis, also in diabetes depending upon a gouty taint. Lithium salts are *diuretic* and are said to increase the elimination of uric acid.

What are the therapeutic uses of sodium salicylate?

Sodium salicylate is largely employed as an *antirheumatic* and antineuralgic, rarely as an antipyretic. It is useful in acute and subacute rheumatism, lumbago, sciatica, the migraine of rheumatic persons, lithemia, pleurisy, stomatitis, acute tonsillitis, and in gastro-intestinal catarrh.

What are (a) the therapeutic uses of salicylic acid and (b) with what base is it often combined?

(a) See next question. (b) Sodium.

For what pathologic conditions is salicylic acid administered? What symptoms indicate the discontinuance of the use of salicylic acid?

Externally, salicylic acid is an antiseptic and is employed as a surgical dressing. It is also used for the removal of warts and corns, in bromidrosis, eczema of the moist variety, and as an injection for thread-worms.

Internally, it is employed in acute and subacute rheumatism, lithemia, lumbago, sciatica, migraine of rheumatic origin, stomatitis, acute tonsillitis, pleural effusion, and diabetes.

Salicylic acid disorders the digestion, produces headache, tinnitus aurium, occasionally erythema or acne, delirium, disturbances of vision, profuse sweating, marked fall of temperature, and feeble pulse. If any of these symptoms occur with sufficient intensity to warrant it, the drug should be discontinued.

Name, with dose of each, the preparations of salicylic acid. Give its physiologic action and state in what form it is to be administered.

Sodium salicylate, Lithium salicylate	dose	5 to 30 gr.
Ammonium salicylate	"	2 to 10 "
Bismuth subsalicylate	"	2 to 10 "
Methyl salicylate	"	5 to 15 min.

Upon the nervous system salicylic acid produces little effect in medicinal doses. It causes ringing in the ears, decrease of the reflexes, and in poisonous doses epileptiform convulsions. Upon the circulation it is a feeble depressant in medicinal amounts. The respiratory center and peripheral vagi are feebly stimulated by moderate amounts. Death from toxic doses is due to respiratory failure. The normal bodily temperature is slightly depressed; upon febrile temperatures it has distinct *antipyretic* power. It is absorbed from the stomach as sodium salicylate, and as such circulates in the blood. It is eliminated by the kidneys as salicyluric acid and colors the urine green; it is also eliminated by the other secretions.

It may be administered in solution of water and glycerin, or syrup of bitter orange peel, or ginger may be added to cover the taste. It may also be given in pill or capsule, but must be accompanied by considerable water or milk and taken after meals.

In what dose may the oil of wintergreen be administered to an adult for rheumatism?

Five to fifteen minims.

What are the therapeutic uses of manganese?

Manganese is employed in amenorrhea dependent upon functional disturbance, and in anemia; the sulfid has been employed in malarial jaundice.

What is the physiologic action of tincture of the chlorid of iron upon the kidneys?

Diuretic.

Define hematics. Mention two principal hematics.

Hematics are agents which improve the quality of the blood. Iron and arsenic.

What serious results may ensue from indiscriminate use of acetanilid?

Toxic doses reduce the oxygen carrying power of the blood and convert hemoglobin to methemoglobin. The alkalinity is diminished, corpuscular destruction and hematuria ensue. Death occurs from paralysis of respiration. After its prolonged use congestion and degeneration occur in the liver, spleen, and kidneys. The chief *symptoms of poisoning* by acetanilid are cyanosis, livid, perspiring, expressionless, or anxious face, soft and compressible pulse, subnormal temperature, and collapse. Addiction to the drug may result from its habitual use.

What are the therapeutic uses of acetanilid administered internally? Has it any uses when locally applied? If so, what are they?

Acetanilid is employed *internally* as an antipyretic, an *analgesic*, and as a sedative and antispasmodic. It is useful in headache, myalgia, and various forms of nerve pain, as sciatica, gastralgia, and the crises of tabes. It is also of value in epilepsy and obstinate vomiting.

Externally, acetanilid is an *antiseptic* and analgesic, and is employed as a dressing for burns, chancroids, and foul ulcers. Poisoning may result from absorption through the skin or an abraded area.

Mention the principal therapeutic application of antipyrin.

The uses of antipyrin are the same as those of acetanilid and phenacetin (*q. v.*). In efficacy it is intermediate between these two drugs, from which it differs by the fact of its *solubility*.

Describe the physiologic action of antipyrin in medicinal doses on the circulation and temperature.

In medicinal doses antipyrin exercises very little influence upon the circulation. It lowers a febrile temperature by increasing heat dissipation and decreasing heat production.

Mention the therapeutic uses of phenacetin.

The therapeutic indications are the same as those of acetanilid (*q. v.*); the drug is not used locally.

What is the dose of phenacetin as an antipyretic?

Two to 10 gr. every four hours.

Give the indications of salol, its dose, and name the two drugs it is subdivided into in the stomach.

Salol is indicated in acute and subacute rheumatism, neuralgia, pharyngitis, intestinal indigestion and fermentation, duodenal catarrh and catarrhal jaundice, diarrhea, cholera morbus, and gonorrhea. *Dose:* 2 to 5 gr. It is decomposed in the small intestine into salicylic acid and phenol.

What is the dose of iodoform when administered internally and in what condition would you so administer it?

One to 5 gr.

In tertiary syphilis. It has also been recommended in pulmonary tuberculosis, catarrhal jaundice, and in the early stages of hepatic cirrhosis.

What are the physiologic effects of iodoform internally administered? State the therapeutic uses of iodoform when externally applied.

Internally, iodoform acts as an *alterative*.

Externally, it is used chiefly as a surgical dressing; it is efficacious for this purpose because it absorbs the liquors of the wound, thereby removing the nidus for germ growth. It also sets free iodin and initiates chemical changes in the bacterial toxins. It is of especial value in *syphilitic sores*, in the treatment of *tubercular disease of the joints and pleura*, in fissure of the anus and irritated hemorrhoids, and in the tenesmus of cholera infantum, as an injection.

Give the therapeutic uses of the iodids. How are they best administered?

The iodids are used as *antisyphilitics*, *antirheumatics*, in metallic poisoning to aid in the elimination of the metal, and for their *alterative effect* in numerous conditions. In small doses they are useful for reducing excessive blood-pressure. Iodids should be taken about one hour after meals, well diluted with water, to which may be added compound syrup of sarsaparilla or fluidextract of licorice. They may also be given in milk or junket.

What is the dose of (a) potassium iodid, (b) ammonium iodid, and (c) sodium iodid?

(a) Potassium iodid, 5 to 60 gr. (b) Ammonium iodid, 2 to 5 gr. (c) Sodium iodid, 5 to 60 gr.

In what form is iodin most frequently administered internally? What is the antidote for free iodin?

Potassium iodid. Starch.

Mention the therapeutic uses of iodin.

Externally, iodin is a slow counterirritant, absorbent, and alterative. It is employed in enlarged lymphatic glands, chronic bone disease, chronic rheumatism, synovitis, pleurisy, chilblains, erysipelas, and in skin affections such as tinea tonsurans and circinata, and lupus.

Internally, it is rarely employed as the tincture in the treatment of the vomiting of pregnancy and after anesthetics.

Give the indications for the use of corrosive sublimate internally.

It is indicated internally in corpuscular anemias, as an *antisyphilitic*, to prevent fibrinous exudation in diphtheria, dysentery, and in the summer diarrheas of children when the stools are offensive and contain blood and mucus.

What are the principal therapeutic uses of the preparations of mercury?

Calomel is employed as a *cholagogue* and mild laxative, as an antisyphilitic, in jaundice, in dropsy as a *diuretic*, to allay vomiting, and to improve the appetite; it is also valuable in acute dysentery. *Externally*, it is applied as a dusting-powder to the eye in cases of phlyctenular conjunctivitis and to condylomata.

The *bichlorid* is a powerful *antiseptic* and germicide and is largely used for surgical asepsis and antisepsis, in all parasitic affections of the skin and in obstinate syphiloderm. Internally, it is employed as an *antisyphilitic*, in corpuscular anemias, in diphtheria to prevent fibrinous exudation, in dysentery and summer diarrheas, and as a cholagogue.

The *biniodid* and *protiodid* are chiefly used as *antisyphilitics*.

Ammoniated mercury and the *red* and *yellow oxids* are used in parasitic affections of the skin, syphilitic sores, chronic scaly skin diseases, and granular lids.

Mercury with chalk is used in infantile syphilis, syphilitic marasmus, and infantile diarrhea.

Blue mass is employed as a *cholagogue and laxative*.

The *yellow subsulfate* has been used as an errhine in chronic ophthalmia and as an emetic in croup.

Mercurial ointment and the oleate of mercury are used externally by inunction in the treatment of *syphilis* and as parasiticides.

Nitrate of mercury is used externally as a *caustic*.

Name four preparations of mercury. Give dose of each.

Massa hydrargyri, dose, 2 to 10 gr.; hydrargyrum cum creta, dose 1 to 10 gr.; hydrargyri chloridum mite, dose, $\frac{1}{10}$ to 10 gr.; hydrargyri chloridum corrosivum, dose, $\frac{1}{100}$ to $\frac{1}{20}$ gr.

Give therapeutic action of mercury.

Mercury is employed for four chief purposes. As an *antisyphilitic* and in kindred conditions, as a *cholagogue laxative*, as an *antiseptic* and germicide, and as an *antiphlogistic*.

What is the proportion of mercury in blue pill? What is the dose of blue pill?

Thirty-three per cent. Two to twenty grains.

(a) What is the official name of calomel? (b) What drugs are incompatible with it, and why?

(a) Hydrargyri chloridum mite.

(b) Calomel is incompatible with alkaline earths, sulfhydrates, salts of iron, lead, and copper; iodin and iodids, cherry-laurel water, bitter almonds,

hydrocyanic acid, ammonium, sodium, and potassium chlorids, and nitro-hydrochloric acid and antipyrin. These substances react chemically with calomel, forming poisonous or deleterious substances.

How may the two chlorids of mercury be administered? In bilious attacks when you give calomel, what remedy often used to allay nausea would you be particular not to give?

The two chlorids of mercury may be administered in powders, tablets, pills, or cachets. The bichlorid may also be administered in solution.

Lime-water.

Describe the physiologic action of arsenic and name three indications for its use.

Externally, it acts as a powerful escharotic if the skin is broken or a wound or sore exists. Upon the nervous system in medicinal amounts it acts as an excitant and as a *stimulant to the trophic nervous apparatus*. In moderate dose it has no effect upon the circulation, large doses cause a decrease in the force and frequency of the pulse with a fall in arterial pressure. The respiratory center is stimulated by small amounts. In toxic quantity it is a powerful respiratory depressant. In medicinal amount it decreases tissue changes.

It is *indicated* in anemia, chorea, and malaria.

Why would you use a strong solution of arsenic when applied over large surfaces? In giving Fowler's solution in increasing doses, what untoward symptom would indicate that the dose should not be further increased?

Strong solutions destroy the tissues before they can absorb the poison.

Puffiness beneath the eyelids, especially in the morning, slight relaxation of the bowels, and griping.

In what diseases are preparations of arsenic useful?

Chorea, corpuscular anemias, malaria, psoriasis and other chronic skin diseases with dryness of the skin and desquamation, diabetes, asthma, chronic rheumatism, coryza, vomiting, chronic diarrhea, and dysentery.

Externally, arsenic in the form of a paste is a destructive *caustic*, and is used for the removal of warts, corns, and epitheliomata.

What is the dose of Fowler's solution and what precautions should be observed in its administration?

Dose, 1 to 5 min., gradually increased. It should be administered after meals, to avoid irritating the stomach. If puffiness about the eyelids or slight laxity of the bowels and griping develop, the drug should be discontinued for a day or more and then resumed in smaller doses.

What are the principal alkaloids obtained from cinchona bark and used in medicine?

Quinin, quinidin, cinchonin, and cinchonidin.

What are the derivatives of cinchona and their doses?

Cinchona contains twenty-one natural alkaloids, and from it are produced eight artificial alkaloids. It also contains numerous acids, a neutral principle, and a volatile oil. The principal alkaloids used medicinally are quinin, quinidin, cinchonin, and cinchonidin.

Quinin is given in doses of 1 to 4 gr. as a tonic; 4 to 60 gr. for anti-malarial purposes. The other alkaloids can usually be given in twice the amount of quinin.

How would you distinguish quinin from the other cinchona alkaloids?

Quinidin differs from quinin in being dextrogyre (quinin is levogyre) and in being almost insoluble in ether.

Quinin solutions, acidulated with HCl and treated with bromin water and then with an excess of ammonia, yield an emerald-green color. *Cinchonin* and *cinchonidin* do not produce this reaction.

Give the physiologic effects of cinchona.

Upon the cerebrum cinchona acts as a stimulant and finally as a congestant, if given in excessive dose. In the lower animals it causes a decrease in reflex activity by stimulating Setschenow's reflex inhibitory center.

Given in small doses by the mouth, it acts as a general stimulant to the entire body, increasing the pulse-rate and blood-pressure. In large doses it acts as a vascular sedative.

In the *blood* it increases the number of red cells, prevents diapedesis of the white cells, and arrests inflammatory exudation. Upon the respiration in small amounts it acts as a slight stimulant; as a marked depressant in poisonous amounts.

It is a powerful *antiperiodic* in malarial fever, in which it is specific.

It is absorbed from the stomach and acts as a tonic and stimulant to that organ. Moderate doses are constipating, large ones may induce colicky pain.

State the contraindications to the use of quinin.

Quinin is contraindicated ing astritis, cystitis, meningitis, epilepsy, cerebritis, and otitis media, because it congests, irritates, or stimulates those areas which are diseased. It is also contraindicated when idiosyncrasy exists.

What are the preparations and doses of gold salts?

The chlorid of gold and sodium (auri et sodii chloridum) is the only official gold salt. Dose, $\frac{1}{10}$ gr.

Describe the physiologic action of phosphorus.

Phosphorus acts as a *tonic to the nervous system* and is a producer of bone, checking tissue waste and diminishing the elimination of urea and carbon dioxid.

Describe the therapeutic uses of the preparations of phosphorus.

Phosphorus acts as a stimulant to the growth of osseous and nervous tissue. It is useful in rachitis, osteomalacia, spinal caries, dental caries, and to promote the formation of callus. It is also useful in nervous exhaustion, in the course of prolonged exhausting diseases, in the sequelæ of acute and chronic alcoholism, sexual exhaustion, boils and carbuncles, in neuralgia due to nerve depression, and in cerebral softening and meningitis of a chronic type.

The drug may be employed as *pure phosphorus*, as the *phosphates*, *hypophosphites*, and *lactophosphates*. *Sodium phosphate* is a laxative and mild cholagogue.

For what medicinal purposes is senna used?

Senna is the most drastic of the laxatives used for the relief of constipation. Used alone, it often produces a great deal of griping. It has been largely used in the constipation of pregnancy.

What is the dose of the fluidextract of senna?

One to 2 dr. for a child; 4 dr. for an adult.

What are the therapeutic uses of podophyllin?

Podophyllin is an excellent cholagogue, and is employed in biliousness and constipation, especially when associated with hepatic torpor and congestion. It is also serviceable in children with summer diarrhea, in chronic diarrhea of adults, in vomiting due to depression of stomach, and hepatic torpor.

What is the physiologic action of rhubarb in dose of 1 to 5 gr.? In dose of 30 to 60 gr.?

In small doses it acts as a mild laxative, improves the appetite, digestion, and intestinal tone. In large doses it acts as a cathartic, having a secondary constipating effect.

What is cascara sagrada? State the dose of the fluidextract of cascara sagrada.

Cascara sagrada, or California buckthorn, is the bark of *Rhamnus purshiana*. *Dose* of the fluidextract, 10 to 30 min.; large doses should not be used.

Give the source, the physiologic action, and the therapeutic uses of oleum ricini.

Oleum ricini is a fixed oil, derived by expression from the seeds of *Ricinus communis*. It acts as a purge, the oil being decomposed by the pancreatic juice, liberating ricin, oleic acid, which is acrid and stimulates the large and small intestine. Its purgative action also depends upon the fact that it is an oil. It is employed as a bland unirritating purge to remove undigested food, mucus, foreign bodies, etc., from the alimentary tract. It is valuable as a preliminary treatment in mucous diarrheas.

On what chemical change in the intestinal tract does the purgative action of castor oil depend?

See preceding question.

What is the common name of oleum morrhuæ? On what physiologic effect does its therapeutic use depend?

Cod-liver oil. It is highly nutritious, its nutritive value depending upon the oil. It is often preferred to other oils because it is more readily absorbed and assimilated. It contains small amounts of iodin and bromin and is said to possess *alterative* properties.

What are the therapeutic uses of magnesia?

Magnesia or magnesium oxid is a *laxative and antacid,* used in acute acid dyspepsia, in diarrhea with excessive acidity in children, sick headache, gout, rheumatism, and various cutaneous affections. It is also an antidote in poisoning by mineral acids and arsenic.

What is the purgative dose of acetate of potassium?

Two to eight drams.

Give the common name and the therapeutic uses of potassium bitartrate.

Cream of tartar. A hydragogue *diuretic* and cathartic, useful in acute nephritis and in chronic parenchymatous nephritis with dropsy. It is usually combined with infusion of juniper berries. For its cathartic effect it is rarely employed.

Give the common name, therapeutic uses, and dose of sodium sulfate.

Glauber's salt. It is employed as a *hydragogue purge* in doses of 2 dr. to 1 oz. Given by the mouth or intravenously, it has been used with asserted success in controlling capillary hemorrhages.

Give the therapeutic uses of sodium sulfate.

Sodium sulfate is employed as a hydragogue laxative in doses of ½ to 1 oz. It is also useful in gastro-intestinal catarrh and catarrh of the bile-ducts.

By the mouth and intravenously it has been employed for the control of capillary hemorrhages.

Give the composition and common name of compound effervescing powder.

Seidlitz powder. The blue paper contains 40 gr. of sodium bicarbonate and 120 gr. of Rochelle salt, the white paper, 35 gr. of tartaric acid.

In what pathologic condition is jaborandi useful?

Nephritis associated with dropsy

Describe the physiologic action and the therapeutic uses of scammonium.

Scammony is an irritant, drastic, *hydragogue purge*, which causes considerable griping and exerts a cholagogue effect. It is employed to unload the bowels and aid in elimination of toxic material, as in uremia with dropsy. It may also be employed in ascites, pericardial and pleural effusions, and general anasarca. In cerebral congestions or effusions it depletes the diseased vessels.

On what physiologic action does the therapeutic use of elaterin depend?

Elaterin acts as a powerful *hydragogue purge*, causing very large, watery stools. It increases the elimination of toxic material through the bowels and promotes the absorption of effusions and transudates.

Describe the therapeutic uses of jalap and state how it differs in effect from aloes.

Jalap is a *hydragogue purge*, producing large, watery evacuations. It also stimulates the liver to greater activity. It is employed to relieve dropsy of any origin and as a depletant in cases of general plethora with cerebral congestion.

Aloes increases peristalsis by acting chiefly on the colon; it is also a *mild cholagogue*. It is slow in its action, and in moderate doses renders the stools thick and pultaceous. It is employed for the relief of subacute and chronic constipation, and combined with iron to aid in the absorption of the metal. It should not be used like jalap to relieve congestions by depletion through the bowel.

State the composition and therapeutic uses of pulvis jalapæ compositus.

Jalap, 35 parts; potassium bitartrate, 65 parts. It is employed as a *hydragogue purge*, producing large, watery evacuations. It is used for the relief of dropsy of any origin and to secure depletion in cases of general plethora and cerebral congestion.

What is the dose of Croton oil as a cathartic? What are the contraindications to its use?

One-half to 1 min., mixed with a few drops of sweet oil or glycerin, and placed on the tongue. It is contraindicated by great debility, in acute inflammation of the stomach and bowels, and in organic obstruction of the bowels.

What are the therapeutic uses of Croton oil?

As a revulsant to rouse the patient in cases of cerebral congestion and apoplexy, and as a *drastic purge* in cases of unconsciousness, delirium, and in the insane.

Externally, Croton oil is a *counterirritant*, and if employed undiluted produces vesication or pustulation. It is employed for its counterirritant effect in neuritis, bronchitis, for sprains, and in muscular rheumatism.

Mention the therapeutic uses of gamboge.

Gamboge is a violent, irritant cathartic, and is used only to give sharpness to purgative combinations. It is one of the ingredients of the compound cathartic pill.

Mention the medicinal uses of the oil of turpentine.

Externally, turpentine is employed as a counterirritant to influence deep-seated inflammation, as subacute hepatitis, and hepatic congestion with catarrhal jaundice. As the *turpentine stupe*, it is frequently employed for the relief of *tympanites*, and biliary, renal, and menstrual colic.

Internally, it is employed by some as a diffusible stimulant during the course of exhausting fevers. For the relief of *tympanites*, in the treatment of intestinal hemorrhage, menorrhagia, hematuria, and also purpura hæmorrhagica. It is *contraindicated* in the presence of acute inflammation of the gastro-intestinal tract and acute nephritis.

What are the physiologic effects of nux vomica on the nerves and circulatory system?

Nux vomica stimulates the motor tracts of the spinal cord, the receptive activity of the sensory centers, and increases the conductive power of the motor and sensory nerves. In poisonous amounts it produces tetanic convulsions. The heart muscle and its ganglia are stimulated, and the force and frequency of the pulse are increased. The drug also stimulates the vasomotor center, causing a rise of arterial pressure.

State the effects of alcohol and strychnin on the arterioles.

Alcohol causes relaxation of the arterioles and increases the elimination of heat. *Strychnin* contracts the arterioles by stimulating the vasomotor center.

Mention the principal physiologic effects of jaborandi.

Jaborandi causes *profuse sweating* by stimulating the sweat-glands and nerves supplying these glands. It also acts as a powerful sialagogue and as a cardiac depressant. It lowers bodily temperature by causing dilatation of peripheral capillaries and profuse sweating. Contraction of the pupil occurs from stimulation of peripheral ends of motor oculi in the iris. Nausea and vomiting may be caused by irritation of the stomach and perhaps the vomiting center. Jaborandi is also said to increase the secretion of milk and tears.

State the direct and indirect effect of pilocarpin in dropsical effusion.

Pilocarpin produces profuse sweating, which causes greatly increased elimination of fluid and depletion of the blood-vessels; the depleted vessels absorb from the tissue the dropsical effusion, which is eliminated through the skin, kidneys, and salivary glands.

What effect has pilocarpus on (a) the heart, (b) the skin, and (c) the salivary glands?

(a) Pilocarpus is a cardiac depressant, causing the pulse in man to become rapid and feeble.

(b) Diaphoresis, stimulation of the sweat-glands, and the peripheral ends of the nerves supplying these glands.

(c) The secretion is greatly increased.

What are the alkaloids of pilocarpus and how do they compare in physiologic effect?

Pilocarpin, isopilocarpin, jaborin, and pilocarpidin.

Pilocarpin is the most active alkaloid and the one commonly employed. *Jaborin* has an action similar to that of atropin and, therefore, is antagonistic to pilocarpin.

Give the dose of (a) pilocarpin and (b) elaterin.

Pilocarpin hydrochlorid, $\frac{1}{10}$ to $\frac{1}{2}$ gr.; elaterin, $\frac{1}{30}$ to $\frac{1}{16}$ gr.

Give the diaphoretic dose of pilocarpin when employed hypodermically, and state the conditions that strongly contraindicate its use.

One-twentieth to one-eighth grain.

Pilocarpus is a cardiac depressant and is contraindicated when cardiac feebleness is present. It would also be contraindicated in cases of ptyalism.

Mention the physiologic effects of bryonia. What is the dose of the tincture of bryonia?

In moderate doses bryonia causes flushing of the face and neck and headache in susceptible persons. In overdoses it acts as a hydragogue cathartic and gastro-intestinal irritant. On serous membranes it exercises an irritant influence and may produce symptoms of meningitis. *Dose* of the tincture is 10 min. to 2 dr.

What is the physiologic action of colchicum?

Colchicum in full doses acts as an emetic, as a purge, as a cholagogue, and in large amounts as a violent gastro-intestinal irritant. Death results from paralysis of respiration.

The drug is employed as a remedy for gout, its use being entirely empiric.

From what parts of the colchicum plant is the active principle obtained?

The corm and the seed.

What are the therapeutic uses of uva ursi? What part of this plant is used in medicine?

Uva ursi is a weak, astringent diuretic, acting as an alterative to the genito-urinary mucous membrane. It is employed in pyelitis, cystitis, and chronic gonorrhea. The leaves.

For what are the preparations of juniper used in medicine?

Juniper acts as a gastric stimulant and tonic, as a mild *diaphoretic* if combined with alcohol, and as a marked stimulating *diuretic*. It is employed in chronic nephritis, renal congestion and inactivity, chronic pyelitis, and cystitis.

What are the physiologic effects and therapeutic uses of cubebs?

Internally, small doses are stomachic and carminative, aiding digestion. It is a stimulating expectorant and a powerful stimulating *diuretic.* Cubebs are employed in chronic pyelitis, cystitis, the late stages of gonorrhea and gleet; as a snuff in coryza, in the form of cubeb cigarettes for the relief of laryngitis and asthma, and in subacute and chronic bronchitis.

How do potassium acetate and potassium bitartrate compare as diuretics and purgatives?

The *bitartrate* is the most active diuretic and probably the most active purgative. The potassium *acetate* also acts as a mild cholagogue.

Describe cantharis and name four official preparations.

Cantharis is a beetle known as *Cantharis vesicatoria.* It appears with iridescent coverings or wing-sheaths of a bluish or greenish hue. It is obtained principally in Spain, Italy, Sicily, and Russia. The active principle is cantharidin, but as such it is not employed.

Tinctura cantharidis, ceratum cantharidis, collodium cantharidatum, emplastrum cantharidis.

What are the uses of cantharis (a) externally applied, (b) internally administered?

Externally, cantharides is used as a vesicant, to promote the absorption of effusions and to influence deep-seated inflammations.

Internally, it is employed as a uterine stimulant, in chronic parenchymatous nephritis, chronic pyelitis and cystitis, incontinence of urine, chordee, impotence due to sexual excess, gleet, and prostatorrhea. It has also been used in psoriasis, eczema, lichen, and prurigo.

What are the varieties of sinapis used in medicine, how are they used, and for what purpose?

Sinapis alba and *nigra.*

Internally, mustard flour is used as an *emetic* in cases of poisoning and to unload the stomach in cases of indigestion. It is also employed as a condiment. The *oil of mustard* is used as a stimulant and carminative, especially in atony of the stomach of alcoholics.

Externally, mustard is used as a *counterirritant* in the form of a paper, as a poultice mixed with wheat flour, or as the compound mustard liniment. In these various forms it is useful to relieve the pain of colic due to flatulence and acute inflammations of the abdominal and thoracic viscera, that due to muscular rheumatism, inflamed joints, and neuralgia, and applied to the nape of the neck in cases of headache and cerebral congestion.

Describe asafetida and outline its physiologic effects.

Asafetida is a gum-resin obtained by incising the root of *Ferula fœtida.* It occurs in irregular masses, of a dark yellow or reddish color, which become more red when exposed to light and air, and has a strong penetrating odor, resembling that of garlic. Resin-gum and a sulfurated volatile oil enter into its composition.

Asafetida is employed chiefly as a *carminative*, for flatulent colic in children, intestinal indigestion associated with flatulence, tympanites occurring during the course of acute infectious diseases. It is also a stimulating expectorant and is used in the later stages of bronchitis. As a *sedative*, it is serviceable in nervous irritability of children, minor spasms, and whooping-cough.

What action on the heart has valerian in full doses? State the therapeutic uses of valerian.

Full doses of valerian act as a moderate stimulant to the heart, causing acceleration and finally lessened frequency. Valerian is used in nervousness, insomnia, hysteria, and, combined with more powerful drugs, in the treatment of delirum tremens.

What are the therapeutic uses of the preparation of valerian?

The tincture is employed in nervousness, hysteria, insomnia, and delirium tremens.

Mention the therapeutic uses of nitric acid.

Externally, it is employed as a *caustic* and escharotic for chancroid, warts, gangrene, and in phagedenic ulcers. In dilute form it is stimulant and astringent to indolent ulcers.

Internally, it is *tonic* and *astringent*, and is serviceable in gastric indigestion, intestinal indigestion, in the green and lienteric diarrheas of children, and in the oxalic acid diathesis.

What are the physiologic effects and therapeutic uses of chromic acid?

Chromic acid or chromium trioxid is a powerful *caustic and escharotic*, and will dissolve almost any form of tissue. It is also a powerful oxidizer. It is employed for the removal of warts, corns, condylomata, and similar conditions, and in rhinologic and laryngologic practice.

Internally, it is a violent, corrosive poison.

Give the therapeutic uses of ammonium carbonate.

As a *heart stimulant*, especially in children. Its principal use is as a stimulating *expectorant*.

What are the therapeutic uses of cardamom?

Cardamom is used as a *carminative*, to expel flatus, in atony of the stomach and small intestine, as an agreeable vehicle, and as a placebo.

What are the therapeutic uses of tincture of capsicum internally administered? State the dose of the tincture of capsicum.

Capsicum is employed in atony of the stomach, subacute alcoholism, flatulent colic, anorexia, chronic nephritis, sore throat, relaxed uvula, and simple tonsillitis. *Dose* of the tincture is 5 to 20 min.

How do the preparations of gentian affect the human system and in what conditions are they indicated?

Gentian is an excellent *bitter tonic*, stimulating the gastric mucosa and increasing the secretion of gastric juice. It is valuable in anorexia and in digestive disorders depending upon atony, depression of the gastric mucous membrane, also combined with alkalis in the treatment of subacute and chronic gastro-intestinal catarrh.

What are the therapeutic uses of acetic acid?

Locally, acetic acid in concentrated form is caustic and is employed for the removal of warts, condylomata, etc. In dilute form it is applied over bruises, sprains, and dermatitis due to sunburn; also as a lotion to check night-sweats and for the arrest of small hemorrhages.

Internally, it is used as an antidote to poisoning by strong alkalis and as an antiscorbutic. The fumes of vinegar or the dilute acid are inhaled to check vomiting.

For what is hydrochloric acid used in medical practice?

Hydrochloric acid is indicated when the gastric juice is deficient in this acid. It is, therefore, useful during and after fevers, especially typhoid, gastric carcinoma, chronic gastric catarrh with dilatation, and in the gastritis following the abuse of alcohol. In small, so-called tonic doses, it forms an excellent adjuvant to nux vomica in digestant mixtures.

Mention the therapeutic uses of hydrocyanic acid.

Hydrocyanic acid is employed in irritable coughs, gastralgia, nervous vomiting, irritable stomach, enteralgia, and *externally* as an antipruritic to allay itching in pruritus pudendi, pruritus ani, and various skin diseases attended with itching.

In what diseases is conium used?

Conium depresses the motor nerves, and has been employed in various spasmodic affections, such as chorea, paralysis agitans, and whooping-cough. Also in maniacal and hysteric excitement. It is especially valuable for the relief of pain and irritation due to pressure upon motor nerve-trunks.

What are the preparations and doses of conium?

Conium, 3 gr.; fluidextract of conium, 3 min.; fluidextractum conii, 2 to 6 min.

What are the therapeutic uses of lobelia?

Lobelia is used as an expectorant in acute bronchitis, in bronchial asthma, rarely as an emetic, and in atonic constipation.

Externally, it is employed as the infusion for the dermatitis of ivy poison.

What is heroin? Describe its physical properties and physiologic action. Give some indications for its use.

Heroin is the diacetyl-acid-ester of morphin. It is a white, crystalline powder, without odor and of a slightly bitter taste. Heroin is a *sedative*

to the bronchial mucous membrane, and is also stated to be slightly stimulant to the respiratory center. The chief indication is to *allay cough*. It is said to be of value in uremic dyspnea.

What are the medicinal uses of ipecac?

Ipecac is used as an *emetic*, in cases of obstinate vomiting due to depression of gastric mucosa in acute dysentery, especially the tropical form; as an *expectorant* in the early stage of bronchitis, in croup to produce emesis and relax spasm. As a diaphoretic, and *externally*, in the form of a paste for the relief of pain and swelling due to the stings of bees.

What are the therapeutic uses of tar?

Tar is a stimulant to mucous membranes in subacute and chronic inflammations. It is useful in subacute and chronic bronchitis and gastro-intestinal catarrh.

Externally, it is used in chronic skin affections, especially of the dry, scaly type, as chronic eczema.

What are the therapeutic uses of guaiac?

Guaiac is used in the treatment of rheumatism, gout, and allied conditions; in acute tonsillitis, and at one time in the treatment of syphilis.

What are the physiologic effects and the therapeutic uses of the balsam of Peru?

Externally, it is a stimulant when rubbed into the skin or applied to raw surfaces, also a parasiticide. It is applied to indolent sores, chronic eczema, cracked nipples and lips, and as a parasiticide for pediculi, scabies, and ringworm. *Internally*, it is stomachic, carminative, and stimulant to mucous membranes, being chiefly used for chronic inflammation of the gastro-intestinal and respiratory tracts.

Give the common name and the official preparations of prunus Virginiana.

Wild cherry. Infusum pruni virginianæ. Fluidextractum pruni virginianæ. *Syrupus pruni virginianæ.*

Name two remedies which are commonly used to promote intestinal peristalsis.

Strychnin and belladonna.

What medicine would you give to promote bone growth?

The calcium salts, especially the lactophosphate and hypophosphite.

What condition of the eye contraindicates the use of mydriatics?

Glaucoma and similar conditions in which intra-ocular tension is increased.

In night-sweats name the drugs indicated, their doses, and methods of administration.

Camphoric acid, dose, 20 to 30 gr. It is to be administered in capsules or cachets, one to two hours before the expected sweat.

Atropin, dose, $\frac{1}{50}$ to $\frac{1}{75}$ gr.; administered by the mouth in form of tablet triturate. If the sweating is very profuse, it may be given hypodermically.

Agaricin, dose, 5 gr.; to be administered every four hours by the mouth.

Name two drugs, giving dose and method of administration, for the treatment of any one form of dropsy and explain how they act.

Caffein is useful in dropsy due to chronic nephritis; it stimulates the renal epithelium and causes a greatly increased flow of urine. Dose, 1 to 5 gr.

Compound jalap powder produces large, watery evacuations and causes the blood-vessels to absorb the fluid from the tissues. Dose, 20 to 30 gr.

Name three remedies indicated in diarrheal disorders, giving the dose and methods of administration.

Magnesium sulfate in mucous diarrhea, to remove decomposing food and mucus from the bowels; dose, 1 to 8 dr. by the mouth.

Aromatic sulfuric acid, especially valuable in serous diarrheas. Dose, 5 to 20 min. by mouth, every two hours.

Podophyllin, when the liver is at fault. Dose, $\frac{1}{10}$ to $\frac{1}{4}$ gr. every two hours.

Name three drugs used to arrest hemorrhage from the lungs and explain how they accomplish the result.

Opium, in its various forms. It checks hemorrhage by quieting the restlessness of the patient and depressing the circulation.

Nitroglycerin, which causes dilatation of the peripheral vessels and slows the current, allowing time for the blood to clot.

Gallic acid is supposed to contract the blood-vessels.

Explain the principle governing the treatment of convulsions when due to toxic agents in the blood. Name two conditions and give treatment.

Convulsions due to toxic agents are to be treated by stimulating all the inunctions to increased activity, thus aiding in their elimination.

Eclampsia and uremia. In both conditions *venesection*, followed by the intravenous infusion of physiologic salt solution, is indicated. Chloroform to control convulsions, or chloral and bromids per rectum. Calomel and hydragogue purges. Stimulate the kidneys to increased activity by alkaline or stimulating diuretics, salt solution by hypodermoclysis or intravenously, which also dilutes the poison. Hot packs or the hot-air bath to increase elimination through the skin.

Differentiate the conditions in which opium and hyoscin should be used to promote sleep.

Hyoscin is especially valuable as a hypnotic when insomnia is due to nervousness, alcoholism, delirium tremens, and allied conditions, and in the treatment of the opium habit.

Opium should be used when insomnia is due to severe pain.

State when calomel or podophyllum should be given and give the reason for the selection.

When the stools are clay-colored and pasty, calomel is indicated; when they are dark and foul-smelling, give podophyllum.

Give the reason which would determine the employment of a vegetable or a mineral astringent in acute inflammatory conditions.

When it is especially desirable to avoid irritating the inflamed area, the mineral astringents are indicated, especially silver nitrate, lead subacetate, and bismuth subnitrate, which are sedative.

For what purposes and effects is strychnin frequently used in formulæ for cathartics?

Strychnin aids peristalsis by stimulating the unstriped muscle-fibers of the bowel. It prevents the depressing after-effect upon the bowels which usually follows the administration of cathartics.

What is glycerin and what are its therapeutic uses?

Glycerin is a triatomic alcohol, obtained by the decomposition of fats and fixed oils. It is usually obtained as a by-product in the manufacture of soap; the alkali combines with the fatty acids, the glycerin being set free. It is principally hygroscopic, extracting fluid from the tissues. It is employed in acute inflammations or congestions, as congestion of uterine cervix and coryza. In the form of a suppository it is useful as a laxative to empty the lower bowel. It is also used as a mouth-wash, for the prevention of bed-sores, as a solvent for more potent remedies, and as a secreting agent in diabetes.

State the dose of (a) tincture of benzoin, (b) benzoic acid. Give the therapeutic uses of benzoic acid.

Tincture benzoin, ½ to 1 dr.; benzoic acid, 10 to 40 gr.

Benzoic acid is an antiseptic; being eliminated as hippuric acid, it renders the urine acid and is useful in chronic cystitis with alkaline urine. It is also valuable in acute rheumatism, chronic bronchitis, and acute laryngitis with great hoarseness.

In what strength would you use solutions of nitrate of silver, borax, permanganate of potash, bichlorid of mercury, and creolin for injection into the bladder?

Silver nitrate, 1 to 2000; borax, 1 to 50; potassium permanganate, 1 to 5000; bichlorid of mercury, 1 to 4000; creolin, 1 to 2 per cent.

What is the source of duboisin and what are its physiologic effects?

Duboisin is the alkaloid of the leaves of *Duboisia myoporoides*, a plant of Australia. It tends to decrease urinary secretion and to disorder digestion, it also produces a soapy taste in the mouth and excessive dryness of the mucous membranes. It is employed as a *mydriatic* and cycloplegic, as a hypnotic, and has also been used in paralysis agitans and epilepsy.

What are the uses of apomorphin? State the dose of apomorphin.

Apomorphin is a rapidly acting centric *emetic.* It is useful in poisoning by other drugs, especially depressants and narcotics, and in catarrh of the stomach and respiratory tract, to remove mucus. It is also serviceable in acute bronchitis and as a nervous sedative in alcoholic excitement and delirium tremens.

Emetic dose, $\frac{1}{10}$ to $\frac{1}{5}$ grain hypodermically; *expectorant dose,* $\frac{1}{40}$ to $\frac{1}{25}$ grain by mouth.

What effect has benzoin on the urine? Name the preparations of benzoin.

It is eliminated as hippuric acid and renders the urine acid.

Acidum benzoicum, sodii benzoas, ammonii benzoas, lithii benzoas, tinctura benzoini, tinctura benzoini composita, adeps benzoinatus.

For what is copaiba used in medical practice?

Copaiba is a stimulant to the genito-urinary mucous membrane. It is indicated when this membrane is the subject of subacute or chronic inflammation, such as chronic pyelitis, chronic cystitis, and urethritis.

What are the therapeutic uses of buchu?

Buchu is a stimulant to the genito-urinary mucous membranes, and is indicated in chronic inflammation of these structures. It is useful in pyelitis, ureteritis, cystitis, incontinence of urine, and urethritis.

Name the official preparation and state the therapeutic uses of santalum album.

Oleum santali. It is a stimulant to mucous membranes which are chemically inflamed, and is used in chronic gonorrhea and gleet, chronic cystitis, subacute and chronic bronchitis, and sometimes in asthma and cases of excessive cough.

Describe the therapeutic action of spigelia. What are its therapeutic uses?

Spigelia or pink root is a vermifuge, and is used for the removal of the round-worm. It is commonly employed as the unofficial fluidextract of spigelia and senna. Dose for a child of two years, $\frac{1}{2}$ to 1 dr., and for an adult, 4 dr. Toxic doses produce symptoms resembling those of belladonna poisoning: delirium, convulsions, dilated pupils, blindness, and loss of speech.

What is the alkaloid of pomegranate and for what is it used?

Pelletierin. It is used for the removal of the tape-worm.

Where is kousso obtained, what preparation is used, and for what purpose?

Kousso is derived from *Brayera anthelmintica*, a plant of Abyssinia. It is used in the form of the infusion or fluidextract as a remedy for the tape-worm.

What is pepo? State its therapeutic use.

Pumpkin-seed. It is used for the removal of the tape-worm.

What are the therapeutic uses of tartar emetic?

Circulatory sedative, in sthenic inflammations.
Expectorant in bronchitis, to remove mucus.
Counterirritant, producing pustulation.
Diaphoretic; for this purpose it is too depressant and is rarely used.

Mention the official preparations of copper. Give the dose of each.

Cupri sulphas. *Emetic* dose, 5 to 7 gr.; *non-emetic* dose, ¼ to 1 gr.

What preparations of copper are used in medicine, and for what purposes?

Copper sulfate and arsenite are the salts chiefly employed. Copper sulfate is the chemical antidote to phosphorus; it also produces emesis. It is employed in diarrheas depending upon ulceration of the bowels, skin disease of the dry type, as an application to indolent ulcers, in subacute and chronic conjunctivitis, relaxed sore throat, and in anemia as the arsenite.

Would you administer charcoal internally, and if so in what dose and for what purpose?

Charcoal is quite bulky and is best administered in the form of cachets. It is useful in atonic or subacute gastric catarrh, especially when associated with eructations of gas or sour fluids, in fermentative and acid diarrheas. *Dose:* 5 to 20 gr.

State the physiologic effects of physostigma on the respiration, the heart, and the pupil of the eye.

In moderate amount physostigma does not affect the circulation or respiration. Moderate doses at first produce a rise of arterial pressure, due to stimulation of heart muscle and of muscular coats of the vessels; the pulse is slowed by stimulation of peripheral vagi. Toxic doses produce death by paralysis of the respiratory center. Physostigma contracts the pupils by stimulating the oculomotor nerves peripherally and by causing contraction of the blood-vessels of the iris. It decreases intra-ocular tension, temporarily increasing accommodation for near objects, and then causes spasm of accommodation.

Give the therapeutic uses of eserin and name its chief antagonist.

Eserin is of value in atony of the bladder and intestines and in catarrh of the bowels. It is also useful in gastric and intestinal dilatation, tympanites, bronchial asthma, and emphysema. It has been employed in various spasmodic conditions, in purgative pills, to stimulate muscular fibers of bowel, in corneal ulcerations, glaucoma, and to overcome atropin mydriasis.

Atropin is the chief antagonist.

From what is eserin obtained? Describe its action.

Physostigma or Calabar bean.

Nervous system: In medicinal amounts it acts as a mild nervous sedative; poisonous doses depress the sensory side of the cord and the peripheral ends of the motor nerves and cause twitchings of the voluntary muscles. The circulation is not influenced by medicinal amounts, poisonous doses produce a rise of arterial pressure by stimulating the heart and the muscular coats of the vessels, and slow the pulse by stimulation of the peripheral vagi.

Respiration: In moderate amounts has no influence; in toxic doses produces death by paralysis of the respiratory center.

Eye: Causes contraction of pupil by stimulating motor oculi peripherally and causing contraction of blood-vessels of iris. It decreases intra-ocular tension, produces temporarily an increase in the power of accommodation for near objects, and causes spasm of accommodation.

Alimentary canal: Stimulates the unstriped muscle-fibers of the bowel and increases peristalsis.

In what pathologic conditions is digitalis indicated and contraindicated? Describe its action.

Digitalis is indicated as a *cardiac stimulant* in valvular lesions of the heart with ruptured compensation except aortic regurgitation, and in cardiac weakness from collapse, injury, poisoning, shock, or that occurring during acute infectious diseases, provided the temperature is not high; as a *diuretic* when the kidneys are congested from cardiac feebleness; as the physiologic antidote to aconite poisoning. It is *contraindicated* in cases of marked atheroma of the blood-vessels, aneurysm, apoplexy, fatty degeneration of the heart, and the presence of arterial excitement.

Digitalis stimulates the heart muscle, the pneumogastric nerves, both centrally and peripherally; the vasomotor center, and the muscular coats of the blood-vessels. As a result of this action it prolongs the cardiac diastole, slows the pulse, increases the volume of circulating blood, and raises the arterial tension.

Mention three drugs used to accelerate the action of the heart and give the dose of some preparation of each.

Ammonia; aromatic spirits, 10 to 60 min. Atropin; atropin sulfate, $\frac{1}{150}$ to $\frac{1}{75}$ gr. Ether; Hoffmann's anodyne, 20 to 60 min.

Name three drugs used to retard the heart's action and state the dose of some preparation of each.

Aconite; dose, 3 to 15 min. of the tincture; veratrum, dose, 1 to 5 min. of the tincture; antimony, dose, $\frac{1}{20}$ to $\frac{1}{10}$ gr. of tartar emetic.

State the condition of the venous system and that of the arterial system that indicate the use of digitalis, and what effect this drug has on the arterioles.

Digitalis is indicated when the pulse is frequent, with small volume and low tension, with perhaps arrhythmia, a condition commonly found

in cardiac failure. When the venous system is congested in cardiac affections, digitalis is indicated.

Digitalis stimulates the muscular coats of the arterioles and raises arterial tension.

What remedies are useful in cerebral anemia and in cerebral hyperemia? Give doses and methods of administration.

Cerebral anemia is to be treated with cardiac stimulants, such as tincture of digitalis, 5 min., three times a day; strychnin sulfate, $\frac{1}{40}$ gr., three times a day; atropin sulfate, $\frac{1}{100}$ gr., every three hours. Maintaining a lowered position of the head in acute cases is useful. Hydrotherapy in the form of the cold drip-sheet is suitable in cases depending upon faulty distribution of the blood.

Cerebral hyperemia is to be treated by rest, both physical and mental, by cold applications to the head, combined with elevation; by the administration of saline purges which produce large, watery evacuations, and cardiac sedatives, such as tincture of aconite, 3 min., every two hours.

Name four drugs used in the treatment of bronchorrhea and explain their action.

Alum, 20 gr. to 10 oz. of water, as fine spray, and gallic acid, for their astringent effect; creosote and terpin hydrate, for their expectorant and disinfectant action.

For what pathologic conditions may capsicum be used?

Capsicum is a stimulant to the gastric mucosa, and is indicated in atony of the stomach due to general debility, errors in diet, and alcoholism; in flatulent colic as a carminative, in sore throat, and simple tonsillitis. Externally, it is counterirritant and is indicated in rheumatism, lumbago, and chilblains.

Differentiate the physiologic effects on the gastric juice and on the urine of the administration of potassium bicarbonate before and after meals.

Potassium bicarbonate taken before meals is said to increase the acidity of the gastric juice; after meals it decreases the acidity. It renders the urine alkaline.

Mention two remedies commonly used to increase intestinal peristalsis.

Belladonna and strychnin.

On what theory can the use of salol in diarrheal diseases be advocated?

Salol is an intestinal antiseptic, being decomposed in the alkaline medium of the small intestine into salicylic and carbolic acids. While complete antisepsis of the alimentary tract is impossible, salol may diminish the number of bacteria present.

Name a drug commonly used which affects the color of the stools without altering the constituency, and explain the cause.

Iron, which unites with the hydrogen sulfid in the bowel, to form the black sulfid of iron.

In what conditions may cathartics be useful in the treatment of diarrhea or dysentery?

Cathartics are indicated in the treatment of diarrheas and dysentery when irritating substances, such as undigested food, foreign bodies, and micro-organisms, are retained within the intestinal tract. They are of especial value in the so-called mucous diarrheas, and as a rule are contra-indicated in serous diarrhea.

Name three drugs used in the treatment of intermittent fever. State how each controls this disease.

Quinin, methylene-blue, and eucalyptus are used in the treatment of malarial fever. They all exert a specific influence upon the plasmodium, destroying it and preventing its development. Quinin acts both as a prophylactic and as a curative. It should be administered so that its full influence is felt, not only at the time of the expected paroxysm, but one-half to one hour before that time.

At what two periods in intermittent fever may quinin be administered to produce the best results, and in what doses?

Quinin may be administered in hourly doses of 2 to 5 gr., or in one or two large doses of 10 to 30 gr., before the expected paroxysm—say, from thirty minutes to one hour—so that its full influence will be felt at the time of the paroxysm. If the paroxysm is impending, it should be given in solution in acidulated water.

Give the theory of the alkaline treatment of rheumatism.

The vegetable salts of potassium and sodium, such as the citrate and acetate, are changed in the blood into the alkaline carbonates. They thus increase the alkalinity of that fluid; they also favor oxidation, are diuretic, render the urine alkaline, and aid in the elimination of waste products.

Explain how saline cathartics are beneficial in septic peritonitis, and why hypodermoclysis of normal salt solution is indicated in the same affection.

Saline cathartics empty the bowel, and by the free watery evacuations deplete the inflamed peritoneum.

Hypodermoclysis of normal salt solution dilutes the toxins in the blood and aids in their elimination through the kidneys.

What remedies are employed to correct anemic conditions, and how are they used?

The cause of the anemia should be determined and removed, if possible. *Iron* is especially valuable when marked diminution in hemoglobin is present. *Reduced iron* is the best preparation, and should be administered

after meals in small dose, $\frac{1}{6}$ to 1 gr. *Arsenic* and *bichlorid of mercury* are indicated when the erythrocytes are deficient, and should be given after meals in doses varying from $\frac{1}{60}$ to $\frac{1}{20}$ gr. *Quinin* and *manganese* are useful under the same condition.

The diet should be highly nutritious, and readily digested and assimilated. Constipation should be corrected. Fresh air and sunshine, with properly regulated exercise, are valuable aids in the treatment.

Mention four remedies used to control vomiting and state the dose of each.

Sodium bromid, 5 to 20 gr.; cerium oxalate, 1 to 5 gr.; menthol, 1 to 2 gr.; sodium bicarbonate, 5 to 15 gr.

Name three drugs which are administered internally to arrest bleeding.

Opium, nitroglycerin, adrenalin, gallic acid, ergot (in *postpartum hemorrhage*), cotarnin hydrochlorate (stypticin).

What remedies should be used for hemorrhages from mucous surfaces?

When they can be directly applied, astringents and vasoconstrictors are indicated. Tannic acid, alum, Monsel's solution, and adrenalin. For inaccessible mucous surfaces, opium, nitroglycerin, gallic acid, adrenalin, and stypticin are useful.

With what remedies should spasmodic croup be treated? Name three suitable ones.

With emetics, such as syrup of ipecac, antimony, and potassium tartrate. Steam inhalation and heat fomentations to the larynx, antipyrin, antimony, potassium tartrate, and ipecac in non-emetic doses to prevent recurrence of attack. Pertussin, a fluorid, has recently been introduced for the treatment of whooping-cough.

What drugs would you use hypodermically to meet the following requirements? (a) To stimulate the heart's action; (b) to produce emesis; (c) to control hemorrhage.

(a) Strychnin, atropin, and ether.
(b) Apomorphin.
(c) Ergot or cotarnin hydrochlorate.

Name some conditions in which the bromids are indicated, and state the method of giving large doses.

Bromids are indicated when overexcitement of nervous protoplasm is present, as occurs in epilepsy, hysteria, convulsions, seminal emissions, nervous insomnia, headache, migraine, and neuralgia; also nervous vomiting. The bromids are given in large doses until the bromid effect is obtained; this is then maintained by smaller doses at infrequent intervals. Arsenic may be used to prevent the development of acne.

State what remedies are used to reduce temperature; explain how they accomplish this result and describe how used.

Antipyretic drugs, such as acetanilid, antipyrin, phenacetin, and guaiacol locally, were formerly used for the reduction of temperature. They reduce temperature by diminishing heat production and increasing heat dissipation. *Hydrotherapy*, which is chiefly resorted to at the present time, consists in immersing the patient in a tub of cold water at such temperature that the patient will react; during immersion active friction is applied; to bring fresh relays of heated blood to the surface an ice-cap is applied to the head and a stimulant administered before and after, if necessary. The same results may be accomplished by *cold sponging*, by means of the *cold pack*, and the *sprinkle bath*. They lower the temperature by causing greatly increased radiation of heat from the surface of the body.

Name four drugs used in the treatment of chronic interstitial nephritis.

Compound spirit of juniper; caffein; potassium bitartrate; nitroglycerin.

State the pathologic conditions for the relief of which diuretics are administered.

Diuretics are administered when there is renal insufficiency, as in the various forms of nephritis and in cardiac feebleness from any cause; to promote the absorption of exudates and effusions; to hasten the elimination of toxic materials from the blood; and to stimulate the kidneys to greater activity when functionally disordered.

Name several drugs that render the urine alkaline; give their indications, doses, and methods of administration.

Potassium citrate, acetate, and bicarbonate. They are useful in acute and subacute rheumatism, the "uric-acid diathesis," urinary incontinence due to acid and concentrated urine, in acute inflammations of the genito-urinary tract to render the urine bland and unirritating; in acute bronchitis potassium citrate is especially useful. Dose, 5 to 20 gr. administered by the mouth, well diluted.

What are the conditions of cystitis that counterindicate the use of alkaline diuretics?

When the urine is alkaline from the decomposition of the urea, with the production of ammonium carbonate, and a deposition of the phosphates.

What class of acids would you use to acidify alkaline urine?

Vegetable acids; benzoic acid is generally selected.

For what pathologic conditions may buchu be used with advantage?

Buchu is a stimulant to the genito-urinary mucous membrane, and is indicated in subacute or chronic inflammations, such as pyelitis, cystitis, and urethritis.

Name the two most important antisyphilitic remedies, the stages in which indicated, and detail the method of administration.

Mercury and the iodids.

Mercury is usually considered to be indicated in the *secondary stage*. It is given in gradually increasing dose, usually in the form of the protiodids, until the full physiologic effect is obtained, as manifested by slight tenderness of the gums, slight salivation and diarrhea, and slight griping pains. The dose is now cut in half, to what is known as the *tonic dose*. The patient is continued on this dose for a period varying from one to three years. If serious symptoms at any time become manifest, the drug is again pushed for the full physiologic effect.

The *iodids* with mercury, constituting the so-called mixed treatment, are usually considered to be indicated in the *tertiary stage*. They are given in increasing dose until full effect is obtained.

In the treatment of syphilitic node or gumma state which should be used, a mercurial or an iodid, and give the reason therefor.

As a syphilitic node or gumma is usually a tertiary lesion, both mercury and the iodids are indicated, so as to get the maximum alterative effect and cause the breaking down of the lesions. The iodids are to be given in ascending doses; the mercury by the mouth, hypodermically, or by inunction, as the exigencies of the case demand.

What two remedies are especially indicated in chronic lead-poisoning? Describe the action in said condition.

The iodids and opium. The iodids form soluble double salts with lead in the tissues and thus aid in its elimination. Opium relaxes the spasm of the bowel, thus relieving pain and constipation.

In chronic lead-poisoning what remedies are indicated and how are they beneficial?

In chronic lead-poisoning the indications are removal of the cause, elimination of the poison from the body, and the treatment of the lesions produced by the poison.

In lead colic *hepatic purges*, such as calomel and jalap, are indicated, also opium and alum; the opium relaxes the spasm of the bowel and permits the bowels to move; it also relieves the intense pain. To aid in elimination of the lead, *potassium iodid* in increasing doses is to be given. It acts by forming soluble double salts in the tissues, which are readily excreted.—In cerebral inflammation due to lead a blister may be applied to the back of the neck; revulsions and a pilocarpin sweat are also useful.—In case of paralysis strychnin and the faradic current are indicated to maintain the nutrition of the muscles.

Name three agents which are used to promote menstruation.

Ergot, cotton-root, and aloes.

Mention the remedy which will arrest the secretion of milk and state how it should be employed.

Belladonna. It may be employed by the mouth, but preferably locally, in the form of the ointment.

Describe the treatment of intestinal indigestion.

Careful study and regulation of the patient's diet. Fats and starches are often to be avoided, or a limited quantity only allowed. Constipation should be corrected. Pancreatin in full dose with sodium bicarbonate is useful, as are also nitric acid and the bitter tonics. In cases accompanied by flatulence carminatives or drugs to stimulate peristalsis, such as strychnin and physostigma; cholagogue, as calomel and podophyllin, are often serviceable. Abdominal massage and faradic electricity are valuable aids.

Give medical treatment of diarrhea.

Diarrhea is a symptom, and depends upon numerous causes. It may be divided into four varieties—(1) mucous diarrhea, (2) serous diarrhea, (3) diarrhea due to deficient glandular action, (4) diarrhea due to ulceration of the bowels.

In *mucous diarrhea* the diet should be liquid and predigested if necessary. An initial purge, such as magnesium sulfate or castor oil, is to be administered to remove mucus and decomposing food. Often this is all that is necessary; or astringents, such as silver nitrate, lead acetate, and tannic acid with opium, may be called for.

Serous diarrhea can usually be treated from the start with astringents, such as kino, krameria, hematoxylon, and aromatic sulfuric acid. The so-called intestinal antiseptics are often serviceable. Of these, carbolic acid (phenol), salol, guaiacol, and beta-naphthol are probably the best. To overcome atony and depression following diarrhea, nitric acid and the bitter tonics are serviceable.

In *diarrhea due to deficient glandular action*, which occurs chiefly in children, pepsin and hydrochloric acid are indicated if the stomach is at fault. If the bowels, especially the duodenum, are at fault, nitromuriatic acid and podophyllin are serviceable.

In *diarrhea due to ulceration*, magnesium sulfate and sulfuric acid, also ipecac, are especially serviceable.

Give the causes and treatment of deficiency in excretion of urea.

Causes: The various forms of nephritis; renal insufficiency resulting from torpor of the kidneys or sluggish circulation; toxemia; diminished oxidation of nitrogenous material; a diet low in nitrogenous substances.

Treatment: The diet should be carefully regulated, and alkaline and stimulating diuretics administered as the case demands. Cardiac tonics when the circulation is feeble; digitalis is especially valuable. In cases due to toxemia elimination must be secured through the kidneys, bowels, and skin. When faulty oxidation is present, active exercise should be advised.

Detail the dietetic and medicinal treatment of gout.

The quantity of food ingested should be materially reduced. It should consist of foods which are not rich or fatty. Milk and eggs, the white meat of chicken, and fruits are serviceable. Red meats, pastries, and all alcoholic beverages should not be allowed. Plenty of pure water should be taken; the so-called lithia waters may be of value.

When an acute attack of gout comes on, the patient should be placed at rest, with the foot elevated. Morphin may be necessary to relieve pain; *wine of colchicum root* should be administered in full dose, 20 min. at once, and increased 1 min. every four hours, until relief is obtained. Active purgation by means of compound powder of colocynth, 20 to 30 gr., is also indicated. The joints may be wrapped in sodium bicarbonate, one part to nine parts of linseed oil.

During convalescence potassium iodid, guaiac, and arsenic are useful. In cases of *retrocedent gout* the heart must be supported by stimulants; heat is to be applied over the belly, or a mustard plaster to the abdomen or chest, as indicated. Alkaline drinks and diuretics are to be administered freely. Opium, if necessary, to allay irritation.

Give the etiology and treatment of rachitis.

Etiology: Faulty diet and unhygienic surroundings; insufficiency of proteids and fats in the food. It frequently occurs in infants fed upon proprietary foods and condensed milk, which contain an excess of carbohydrates and not enough proteids and fats.

Treatment: The diet should consist of nitrogenous food and fat, especially milk, cream, eggs, red meat, and fresh fruit.

Fresh air and sunshine are indispensable in the treatment. *Cod-liver oil*, *phosphorus*, and the phosphate, lactophosphate, and hypophosphite of calcium are all useful.

(a) Give the therapeutic application of drugs in the different stages of pneumonia. (b) Give the comparative value of chloroform and ether as an anesthetic.

(a) In the *stage of engorgement* in sthenic cases *veratrum* and *aconite*, in full doses, may be administered. *Venesection* may be resorted to in this stage in the same class of cases. A hot foot-bath is also useful. Opium may be necessary to relieve severe pleural pain.

In the *stage of solidification* the indications are to support the heart if it becomes feeble or engorged; to reduce the temperature if it becomes excessive; and to stimulate elimination. To support the heart, alcohol, as whisky or brandy, is useful. With empty arteries and low arterial tension *digitalis* is indicated; when the skin is moist and the blood-vessels relaxed, *belladonna* is indicated. To reduce temperature, if excessive, cold sponging is preferable to antipyretics. To *promote elimination* the bowels must be kept open, the kidneys stimulated to activity by plenty of pure water, *alkaline diuretics* and *hypodermoclysis* of normal salt solution.

In the *stage of resolution*, stimulating expectorants, such as ammonium carbonate, ammonium chlorid, and terpin hydrate, are indicated; also tonics, such as strychnin.

(b) *Chloroform* is contraindicated in cases of fatty or dilated heart; when overgrowth of lymphoid tissue is present, as adenoids; and when an idiosyncrasy to chloroform exists. In valvular diseases of the heart ether is preferable. Chloroform is preferred to ether in hot climates, where large numbers of persons are to be anesthetized, in Bright's disease, in cases of aneurysm or advanced atheroma, and in severe cases of bronchitis. In the performance of tracheotomy ether is a safer anesthetic and is usually preferred to chloroform, except in the above-named conditions.

Describe the treatment of bronchopneumonia.

The room should be kept at an even temperature, 65° to 68° F. The air should be kept moist with vapor of water. The *diet* should be liquid, and consist principally of milk, broths, and egg-albumen. The *temperature*, if high, is to be controlled by cold sponging. At the outset a mild purge of *calomel* in divided doses, followed by a saline purge, is to be administered. A fever mixture of potassium citrate, liquor ammonii acetatis, and tincture of aconite may be useful in this stage. *Stimulating expectorants*, such as ammonium carbonate, squills, and senega, are usually indicated at some stage of the disease. When the heart shows signs of failure and cyanosis becomes manifest, *stimulants*, such as strychnin, atropin, ether, and digitalis, are required. Inhalations of oxygen are also of service. When the symptoms become alarming, *alternate hot* and *cold douches* and electricity may be resorted to. *Emetics* are occasionally useful to aid in the expulsion of mucus. Counterirritation to the chest is frequently employed.

Describe the treatment of cerebrospinal meningitis.

In robust persons local abstraction of blood by *wet cups* applied to the nape of the neck often relieves the pain. Cold in the form of *ice-caps* and *spinal ice-bags* is to be applied. Hydrotherapy should be systematically used in the form of a *tub-bath*, at 98° F., every third hour. *Counterirritation* by means of Paquelin thermocautery to skin of back of neck may be useful. *Lumbar puncture* may do good by relieving pressure. *Opium* should be given freely. Other drugs which have been used, but with doubtful benefit, are mercury, potassium iodid, quinin, ergot, belladonna, and physostigma.

The *diet* should be liquid and nutritious, consisting principally of milk, broths, and egg-albumen; forced alimentation with the stomach-tube may be necessary.

Outline the general treatment of acute articular rheumatism. Write a prescription containing at least two ingredients for an adult to relieve pain in acute articular rheumatism.

Rest in bed, which must be continued for a considerable period after inflammatory symptoms have subsided. *Ichthyol ointment*, 50 per cent., applied to joints often affords great relief; splinting of extremities to relieve pain may be advisable. The *salicylates*, the vegetable salts of potash, and the benzoates are the best remedies internally. Phenacetin, antipyrin, and acetanilid are often valuable for relief of pain. The *diet* should be liquid during the inflammatory stage, and consist principally of milk, beef-juice, broths, and gruel. The *temperature*, if high, is to be controlled by cold sponging.

If cardiac complications threaten, a blister to the precordium is indicated. Water should be given freely; alkaline mineral waters are often serviceable.

As soon as convalescence begins, a more liberal diet must be allowed and some iron preparation prescribed to combat the anemia.

℞.	Sodii salicylatis,	
	Sodii bicarbonatis,	*āā* gr. xxxvj;
	Acetphenetidini,	gr. xxiv.—M.

Fiant capsulæ No. xii.
Sig. One capsule every two hours.

Give medical treatment of measles.

Rest in bed, liquid diet, initial purge of calomel in divided doses, followed by a saline. If the *temperature* becomes excessive, it is reduced by tepid sponging. If the *rash* does not come out well, hot drinks and a warm bath will hasten its maturation. *Cough* may be relieved with paregoric, often advantageously combined with squills and ipecac. The nose and throat should be cleansed with a mild alkaline solution. During *desquamation* the skin should be oiled and warm baths given.

Give medical treatment of scarlet fever.

The patient should be *isolated;* the temperature of the sick-room kept constant and the room thoroughly ventilated. The diet should consist of milk, broths, and fresh fruit; water should be given freely. If the *temperature* becomes excessive, it is to be reduced by cold sponging or the cold pack, which also quiets the delirium and allays restlessness. An ice-cap is to be applied to the head. To develop the rash a *warm wet pack* is most serviceable. Chloral may be used to quiet delirium and restlessness.

An *ice-bag* is to be applied to the throat, and chlorate of potash is useful as a *spray*, or applied with a swab to the inflamed mucous membranes. The mouth must be carefully cleansed with a mild alkaline antiseptic solution; and ear complications are to be guarded against. The urine should be examined daily and complicating *nephritis* treated as the symptoms demand. During *desquamation* the skin is to be oiled to prevent diffusion of the scales.

Describe the treatment of a case of diphtheria.

The patient must be strictly *isolated.* The room should be well ventilated, the temperature maintained at about 68° F.; all superfluous furniture removed, and the air should be kept moist with steam.

The *diet* should be liquid, and consist essentially of milk, beef-juice, barley water, albumin water, and broth; nutritive enemata may be necessary. Hydrogen dioxid and Löffler's solution are probably the best applications to the false membrane. The nasal passages should be cleansed with some mild antiseptic, such as boric-acid solution (saturated). Hot applications to the neck are grateful; in some cases cold is preferable. If dyspnea becomes urgent, an emetic of zinc sulfate or ipecac is useful.

Antitoxin is to be administered in all cases, the earlier the better the prognosis. It is to be administered in doses large enough to produce its characteristic effects—at least 10,000 units as the initial dose. Prophylactic

doses may be administered to those in contact with the patient. Nasal and laryngeal cases require larger doses than pharyngeal.

Intubation or *tracheotomy* may be necessary at any time for the relief of asphyxia. Prolonged rest in bed is to be insisted upon.

When paralysis occurs as a sequel, massage, electricity, and strychnin are indicated.

Outline the treatment of uremia.

The indications in uremia are to control convulsions and secure elimination through the skin, bowels, and kidneys.

To secure elimination administer rapidly acting hydragogue purges, such as *elaterin*, $\frac{1}{10}$ gr., or large doses of *calomel*, which not only unloads the bowel, but also acts as a diuretic, or *Croton oil*, 1 to 3 drops.

To increase the activity of the skin, the hot pack or *hot-air bath* is to be administered. *Venesection* is to be resorted to if the individual is robust and high arterial tension is present, and should be followed by the subcutaneous or intravenous injection of saline solution to dilute the poison and stimulate the kidneys to increased activity. *Convulsions* are controlled with chloral (20 gr.), potassium bromid (1 dr.) in starch-water by rectum, and chloroform inhalation.

State the cause and give the treatment of trichinosis.

Cause: Trichinosis is a parasitic affection, due to the *Trichina spiralis*. The trichinæ are ingested with infected pork. The worm finds lodgment in the intestines, the female penetrates the wall, the embryos are discharged into the lymph-spaces, then into the venous system, and finally find lodgment in the muscles, where they excite a myositis.

Treatment: Prophylaxis consists in thoroughly cooking all hog's meat.

If the case is seen soon after infection, purgatives, as magnesia, rhubarb, senna, and calomel, are indicated. Aspidium, santonin, and thymol are also useful at this time. The indications in the stage of invasion are to relieve the pains, to secure sleep, and to support the patient's strength. There is no specific.

Describe the treatment of apoplexy due to cerebral hemorrhage.

The head should be elevated and an ice-cap applied. A hot mustard foot-bath may be given. If the person is robust, with high arterial tension, *venesection*, or, if this is not possible, vascular sedatives, such as *aconite* and *veratrum*, in full doses. *Croton oil*, 1 min., with 5 min. of sweet oil, should be placed upon the tongue to produce free catharsis and relieve the cerebral engorgement. After the clot has become firm, measures to promote absorption are indicated. *Potassium iodid* in ascending doses and *mercury* in small doses are the best remedies. To prevent wasting of the muscles, passive exercises, *massage*, and *electricity* in the form of slowly interrupted current, are to be used; *strychnin* is also serviceable. The patient should lead a quiet life, with carefully regulated diet, meats being used sparingly. Stimulants of all kinds are to be avoided, and a regular action of the bowels is to be maintained.

Give the causes and treatment of palpitation of the heart.

Causes: Valvular disease, hypertrophy, nervous excitement, hysteria, digestive disorders, anemia, exhausting diseases, abuse of tobacco, tea, coffee, and alcohol, and relaxed peripheral vessels.

Treatment: Remove the exciting cause, if possible. When due to digestive disorders, the diet must be carefully regulated and appropriate remedies administered. When due to hypertrophy, aconite and veratrum are useful. Hoffmann's anodyne is valuable in cases of tobacco heart, belladonna when the peripheral vessels are relaxed. Among other remedies of value are digitalis, spartein, cactus grandiflorus, camphor, iron, and arsenic when due to anemia.

How should asthma of cardiac origin be treated?

So-called cardiac asthma is dyspnea resulting from cardiac failure. The treatment depends upon the character of the heart condition. In all cases *rest in bed* is essential. Cardiac stimulants, such as digitalis, strychnin, and atropin are usually indicated. In cases of high arterial tension, increasing the work of the heart, nitroglycerin is valuable. When pulmonary edema is becoming manifest, atropin should be given.

Describe the treatment of night-sweats.

Night-sweats may be controlled by atropin sulfate, $\frac{1}{100}$ to $\frac{1}{60}$ gr.; camphoric acid, 5 to 20 gr.; agaricin, 1 to 2 gr.; or by sponging at bedtime with dilute acetic acid. As they represent an effort at elimination, they should not be checked except for good reason.

Give the treatment of obstinate hiccough.

Hiccough depends for its production upon numerous conditions, such as gastric irritation, nervousness, uremia, and exhausting diseases, such as typhoid fever. If due to gastric irritation, emetics or purges are valuable, also Hoffmann's anodyne, oil of amber, spirit of chloroform, and camphor. When coming on after meals and due to indigestion, a course of tonic treatment should be instituted. In the hiccough of typhoid fever *musk* is especially valuable. *Amyl nitrite* by inhalation and *ether* sprayed upon the epigastrium are serviceable. When due to uremia, hot-packs and other eliminative means are indicated.

Describe the treatment of a case of sunstroke.

The clothing should be removed. If the pulse is bounding, the face cyanotic, and the heart action labored, *venesection* should be performed, followed by the intravenous injection of normal salt solution. *Ice* should be applied to the head and *ice-water* to the body by means of a sponge, or a piece of ice may be rubbed briskly over the surface. Care should be taken that the temperature does not fall too low and collapse ensue. The patient must be carefully watched for some days, for fear meningitis may develop.

What are the causes and treatment of urticaria?

Urticaria is an inflammatory affection, characterized by evanescent whitish, pinkish, or reddish elevations or wheals, and attended by itching, stinging, or pricking sensations.

Causes: Any irritation from disease, functional or organic, of any internal organ, may give rise to the eruption in those predisposed. *Gastric derangement* from indigestible or special articles of diet; intestinal toxins; and the ingestion of certain drugs are often provocative. Various rheumatic and nervous disorders are often causative. External irritants in those predisposed may be responsible. There is marked vasomotor relaxation and in most cases diminished coagulability of the blood.

Treatment: The cause should be sought for and removed. When the urticaria is due to gastric disturbances from improper or indigestible food, a *saline purge*, such as magnesium sulfate, or an emetic, as mustard or ipecac, is indicated; alkalis and intestinal antiseptics are also useful. In chronic and recurrent cases various remedies to act upon the composition and pressure of the blood, such as calcium chlorid, arsenic, sodium salicylate, quinin, pilocarpin, atropin, have been advised. *Externally*, lotions containing carbolic acid, boric acid, or thymol; zinc oxid; and alkaline baths are serviceable.

What is the treatment of scabies?

The treatment consists in giving first a thorough hot-water-and-soap bath, and then applying twice daily for three days a remedy or remedies destructive to the parasites and ova, and finally another bath. Remedies usually employed are *sulfur*, *balsam of Peru*, *styrax*, and *beta-naphthol* in the form of an ointment. The clothing should be boiled.

Describe the treatment of cystitis.

Acute cystitis: Rest in bed, aconite and belladonna combined with potassium citrate or acetate. Belladonna, opium, or iodoform by rectal suppository. Hot enemas and a hot sitz-bath are useful. Hot compresses should be applied over the bladder, or leeches to the perineum, or dry cups to the sacral region. All stimulating foods and alcohol must be avoided. The bowels are to be kept freely opened, preferably with salines.

Chronic cystitis: When mucus is present in large quantities, the urine should be rendered alkaline with liquor potassæ or potassium citrate. When alkaline, with separation of phosphates, urotropin and salol are indicated. Irrigate daily with warm solution of bichlorid of mercury, 1 to 10,000, or silver nitrate, 1 to 5 gr. to the ounce. Cubebs, copaiba, sandalwood, buchu, uva ursi, and cantharides are useful to stimulate the mucous membrane.

How should ophthalmia neonatorum be prevented and how treated?

Prophylaxis: As soon as the head is born, the skin of the lids is washed with solution of mercuric chlorid, 1 to 10,000; the eyes are then irrigated with boric-acid solution, and one or two drops of a 2 *per cent. solution of silver nitrate* are dropped upon the eyeball (Credé's method). The margins of the lids are then anointed with vaselin and cold compresses applied for a few hours.

Curative treatment: Ice compresses are to be kept continuously applied. The lids must be kept free of discharge by irrigation of the conjunctival sac with saturated solution of boric acid or solution of mercuric chlorid, 1 to 5000. Silver nitrate, 10 to 20 gr. to the ounce, is to be applied twice daily to the conjunctiva by means of a cotton-wrapped probe.

TOXICOLOGY

State the antidote to practically all alkaloids, explaining its action.

Tannic acid forms insoluble tannates with alkaloids and their salts.

What are the symptoms of opium-poisoning?

Three stages are described: (1) a brief stage of exaltation, followed by (2) drowsiness with slow, shallow breathing, slow full pulse, dry skin, and contracted pupils, during which the patient can still be roused. (3) The final stage of deep coma, with rapid, feeble pulse, moist skin, cyanosis, complete muscular relaxation, stertorous breathing, soon becoming shallow and irregular, and death from respiratory paralysis.

Describe the symptoms caused by a toxic dose of opium, state with what disease they may be confounded, and outline the indicated treatment.

See preceding question.

Opium-poisoning may be confounded with apoplexy, uremia, or cerebral concussion or congestion.

Potassium permanganate or *tannic acid* is to be administered as the chemical antidote after the stomach has been washed out several times, as the opium is eliminated by the gastro-intestinal mucous membrane. Hot coffee is given by the mouth or rectum to stimulate the respiratory center. *Atropin* and *strychnin* are administered hypodermically as the physiologic antidotes. Ammonia and ether may be necessary as rapidly acting cardiac stimulants. The patient is to be kept awake if possible by means of flagellation, the faradic battery, or by the electric brush. Walking is not advisable, as it exhausts the patient.

Treat a case of opium-poisoning; also give the therapeutic uses of opium.

For the treatment see previous question.

The general indications for the administration of opium are to relieve *pain* and the insomnia caused by pain; to control *excessive nervous excitement* in *brain injuries;* to check *hemorrhage* by quieting the heart action; to check *diarrhea;* to induce *sweating.*

In chronic or recurrent conditions, such as neuralgia, opium should not be given, nor for the relief of insomnia due to nervous excitement. The drug is given empirically in diabetes (usually in the form of codein phosphate) and in cases of inflammation of serous membranes. In very small doses ($\frac{1}{24}$ gr.) it has been recommended in chronic heart disease with great cardiac excitement.

In what manner is the system affected by an overdose of chloral hydrate?

Drowsiness followed by deep sleep and coma. The respirations are at first slow and labored, then shallow and feeble. The pulse, after a slight initial slowing, soon becomes rapid and feeble, and finally disappears at the wrist. The face is white and livid; forehead and hands are covered with a cold sweat. The pupils are first contracted, then become widely dilated;

the temperature is often subnormal, and absolute muscular relaxation is present. Death occurs from respiratory failure, with an almost simultaneous arrest of the heart.

Describe the therapeutic uses and the dangers of chloral hydrate. How does a toxic dose of chloral hydrate affect body temperature?

Chloral hydrate is a hypnotic and antispasmodic. It is useful to *produce sleep* in all cases of insomnia not dependent upon pain. As an antispasmodic it is used in strychnin-poisoning, tetanus, infantile convulsions, infantile colic, chorea, paralysis agitans, delirium tremens, uremic and puerperal convulsions, hiccough, and whooping-cough.

Chloral is a *cardiac depressant*, and symptoms of collapse may ensue. It sometimes causes nausea, vomiting, and purging; also an erythematous, papular, vesicular, urticarial, or petechial eruption. There is also danger of the development of the chloral habit.

Toxic doses produce a marked *fall* in the body temperature.

How should a case of poisoning with chloral hydrate be treated?

Empty the stomach by means of emetics or the stomach-pump. The use of the pump is safer, because emesis strains the heart. The head must be lowered and external heat applied. Rapidly acting, diffusible stimulants, such as ether, ammonia, and brandy, are to be administered hypodermically with digitalis to sustain the stimulating effect on the heart, and strychnin and atropin for their action on the respiration.

Give the preparations of belladonna. Describe the toxic effects and give antidotes.

Preparations: Atropina, atropinæ sulphas, extractum belladonnæ foliorum, fluidextractum belladonnæ radicis, tinctura belladonnæ foliorum, unguentum belladonnæ, emplastrum belladonnæ, linimentum belladonnæ.

Toxic effects: Flushing of the face, dilated pupils, redness and dryness of the fauces, erythematous rash, delirium, occasionally diplopia. The pulse is rapid and wiry. Deep sleep preceded by convulsions may be present; also blindness and loss of speech.

Tannic acid is to be administered as the chemical antidote, followed by emetics or the use of the stomach-pump. Opium is the physiologic antidote, but is to be administered cautiously. Apply external heat if collapse ensues, and administer strychnin if respiration fails.

How should a case of poisoning with atropin be treated?

See previous question.

Discuss the symptoms of cocain-poisoning.

The symptoms of cocain-poisoning are variable. Among those which occur are delirium, loss of speech, blindness, nausea and vomiting, syncope, and unconsciousness. The circulation and respiration are disordered; epileptiform convulsions occasionally occur. Cocain-poisoning frequently follows application of the drug to the urethra.

Enumerate the symptoms arising from a toxic dose of digitalis.

Vomiting, violent and persistent; vertigo, headache, and disordered vision; pain in the back and limbs. The pulse is at first slow, full, and strong in the horizontal position, but becomes rapid and feeble on changing to the sitting posture; later the pulse is small, feeble, and irregular, although the heart action may be strong. Exophthalmos, dilatation of the pupils, blue discoloration of the sclerotics; pallor; finally delirium, stupor, convulsions. The intelligence may be preserved until the end.

How should poisoning by digitalis be treated?

Evacuation of the stomach and bowels; *tannic acid* as an antidote; opium and alcoholic stimulants; rest in the horizontal position; external heat. Physiologic antidotes, such as aconite, must be administered with caution, if at all, on account of their depressant action on the cord.

State the official name and the minimum poisonous dose of (a) strychnin sulfate, (b) morphin sulfate, and (c) chloral. State the antidote for each.

(a) *Strychninæ sulphas:* The average fatal dose for an adult is $1\frac{1}{2}$ to $1\frac{3}{4}$ gr. Death has occurred after the ingestion of $\frac{1}{2}$ gr., and recovery after 19 gr. *Tannic acid* is the chemical, chloral and the bromids the physiologic antidotes.

(b) *Morphinæ sulphas:* The maximum dose that can be administered with safety is $\frac{1}{2}$ gr. Death has occurred from quite small doses; much depends upon idiosyncrasy. *Potassium permanganate* and *tannic acid* are the chemical antidotes; strychnin and atropin the physiologic.

(c) *Chloral hydratum:* Alarming symptoms have followed a dose of 30 gr., death from 30 to 45 gr. Thirty grains in twenty-four hours is usually sufficient. *Strychnin* and *digitalis* are the best antidotes.

What is the antidote for strychnin?

Tannic acid is the chemical, chloral hydrate and the bromids the physiologic antidotes.

Give the symptoms and treatment of strychnin-poisoning.

Toxic doses of strychnin may act suddenly or gradually. If suddenly, the patient may be thrown several feet and become rigid. If gradually, stiffness of the neck and uneasy startings occur, followed by tetanic convulsions, often producing opisthotonos or emprosthotonos. Convulsions are not continuous, and recur at the slightest external stimulus, such as a noise or a draught of air. The convulsions are spinal; consciousness persists; the eyes are open and fixed; risus sardonicus is often present. Death occurs from failure of respiration.

Treatment: Administer *tannic acid* as the chemical antidote, then wash out the stomach by means of the stomach-pump. *Chloral hydrate* and *potassium bromid* are to be administered as the physiologic antidotes; if the convulsions prevent swallowing, administer in starch-water by the rectum. The chloral depresses the motor side of the cord, the potassium bromid the sensory side. *Convulsions* are controlled by the inhalation of amyl nitrite or *chloroform*.

What is the dose of carbolic acid for internal administration? What are the chemical antidotes for carbolic acid?

One-quarter to one grain. The chemical antidote is *any soluble sulfate*, especially magnesium and sodium sulfate or dilute sulfuric acid, which form the harmless sulfocarbolate.

What are the earliest signs of poisoning from the external use of carbolic acid?

Smoky discoloration of the urine, slight nervous unrest or cerebral disturbance, pain in the lumbar region from kidney irritation. These symptoms are most apt to arise after the use of dilute solutions, as in surgical dressings. The strong acid coagulates albumin and contracts the blood-vessels, preventing absorption.

How may carbolic-acid poisoning be produced, and how treated?

Carbolic-acid poisoning may be produced by its local application, especially in dilute solution, and by the ingestion of the acid or its derivatives.

Treatment: Administer any soluble sulfate, such as magnesium and sodium sulfate or dilute sulfuric acid, which form the harmless sulfocarbolates and also act as purges. Evacuate the stomach by means of the pump. Administer warm mucilaginous drinks, alcohol in the form of brandy or whisky, cardiac and respiratory stimulants, such as ammonia, atropin, and strychnin hypodermically; morphin to relieve pain, counter-irritation to the abdomen, and external heat.

What are the possible dangers from the use of salol in large doses?

Large doses of salol may produce symptoms of carbolic-acid poisoning, as the drug is split up in the bowel into salicylic and carbolic acid. The drug is also capable of producing acute nephritis.

Give the symptoms and treatment of acetanilid poisoning.

Poisonous doses of acetanilid produce cyanosis of the lips; the face also becomes cyanosed, livid, expressionless, or anxious, and covered with sweat. The pulse is slow, soft, and compressible. Respirations become slow and shallow.

Treatment: Rapidly acting diffusible stimulants, as ether and ammonia, may be necessary, belladonna to maintain blood-pressure, strychnin to aid respirations, and oxygen inhalations to combat cyanosis. External heat to maintain bodily temperature.

What are the symptoms of iodism? How may it be prevented while the use of the iodid is continued?

The earliest signs of this condition are a metallic taste in the mouth, slight tenderness of the teeth and gums, salivation, morning nausea, lack of appetite, perhaps coryza, and gastric irritation. Acne rosacea is quite common. The patient becomes anemic and emaciated.

Fowler's solution may modify the symptoms of this condition, especially the eruption.

Describe bromism and state how it is produced.

Bromism results from the prolonged use of the bromids. The patient becomes dull, drowsy, and expressionless. Evidences of mental aberration may develop, the patient becoming irritable, morose, and even homicidal. The walk becomes weak and feeble, the movements slow and prolonged. Sense of taste and hearing are impaired. The breath becomes fetid and digestive disorders arise. Loss of sexual power is often an early symptom. Suffocative bronchitis and profound cachexia occasionally develop. Acne commonly appears.

How does a lethal dose of gelsemium affect the system?

A lethal dose of gelsemium produces as prominent symptoms ptosis and dropping of the jaw. These are preceded by a sensation of languor, a desire to lie down, relaxation, and muscular weakness. The pulse becomes rapid and feeble, the skin cold and moist, the face pinched and anxious. Death occurs from centric respiratory failure, with an almost simultaneous cardiac arrest. Temporary internal squint from paralysis of the sixth pair of cranial nerves is sometimes observed.

What symptoms are produced by toxic doses of tartar emetic?

Violent vomiting, first of the contents of the stomach, mucus, bile, watery fluids, and perhaps blood; purging, first of normal contents of the intestine, then mucus and bile, but rarely blood. Following this the peculiar rice-water stools appear. The pulse is extremely frequent and of small volume and tension. The respirations are rapid and shallow. Cramps in the calves of the legs occur. The temperature becomes subnormal. The face is pinched, livid, and covered with a cold sweat.

Describe the forms of poisoning by ergot.

Acute ergot-poisoning is characterized by nausea, vomiting, profuse salivation, thirst, dilatation of the pupils, frequent pulse, tremors, paraplegia, and convulsions.

Chronic ergotism occurs in two forms—gangrenous and spasmodic. *Gangrenous* ergotism begins with itching in the feet, pains in the back, muscular contractions, vertigo; an intense feeling of coldness and aching pains in the limbs and profound apathy develop. Pregnant women abort. Finally a red spot appears in one of the extremities, sensation is lost, and the part eventually becomes *gangrenous*. The gangrene is usually dry. The disease may be fatal or the patient may recover with loss of the affected extremity.

In the *spasmodic* form there is itching, numbness, or complete anesthesia of the fingers and toes or buttocks, gastro-intestinal irritation,—vomiting and diarrhea,—and ravenous hunger. The spasmodic symptoms consist of painful tetanic spasms, chiefly affecting the flexor muscles, and sometimes opisthotonos. Muscular tremors and visual disturbances,—hemiopia and amblyopia,—epileptic paroxysms and delirium, also occur. Death from exhaustion or recovery with permanent damage results.

Describe the lethal effects of hydrocyanic acid.

Death often comes almost instantaneously, the patient is convulsed, the face cyanotic, eyes wide open, teeth tightly shut, lips covered with bloody

froth. If the dose has not been large enough to produce instant death, three stages of poisoning may ensue: (1) Difficult respiration, slow cardiac action, and disturbed cerebration; (2) convulsions; wild cries, dilated pupils, vomiting, spasmodic urination and defecation, erections of penis, and ejaculations of semen; (3) asphyxia, collapse, and death.

What injurious effect is liable to follow the prolonged internal use of the preparations of silver?

Argyria, which results from the deposition of the drug in the form of silver oxid in the skin, producing a pale, slate-blue discoloration. The first signs of discoloration can generally be seen in a darkening of the conjunctiva, over the sclerotic coat of the eye, or in a dark line upon the inner part of the lips. Discoloration is permanent, but may be slightly modified by potassium iodid given to aid in elimination.

Describe the symptoms of hydrargyrism.

Tenderness of the gums when the jaws are firmly and quickly closed, gingivitis, fetid breath, swelling of the tongue, and ptyalism. In severe cases the teeth drop out, the maxillary bones undergo necrosis, and eczema and slough of chin and chest may result from the constant dribbling of saliva. In some cases the nervous symptoms are predominant. Tremors of various kinds arise, paralysis agitans develops, and symptoms of peripheral neuritis ensue. Blindness, deafness, sensory disturbances, such as hyperesthesia and anesthesia, and localized wasting of muscles or groups of muscles may all develop. Mercurial cachexia occurs in some cases.

Mention the symptoms of poisoning by phosphorus.

Peculiar taste of phosphorus in mouth, garlicky odor of the breath, burning pain in the esophagus, stomach, and abdomen, vomiting and purging; the vomited matter and stools are often luminous in the dark. The vomited matter consists first of food, then mucus, bile, and perhaps blood. Constipation may be present. The liver becomes enlarged, giving rise to pain, tenderness, and swelling. In twenty-four to forty-eight hours a remission often occurs, followed by a return of symptoms, such as jaundice, constipation, and clay-colored stools, coffee-ground vomit, nervous symptoms, such as headache, vertigo, muscular twitchings, wild delirium, and convulsions. The urine is scanty, albuminous, and contains sarcolactic acid, leucin, tyrosin, free fat-globules, fatty casts, bile acid and bile coloring-matter, and hypophosphoric acid. Wide-spread fatty degeneration occurs in the viscera. Chronic poisoning usually occurs from inhalation of the fumes; the most prominent symptom is necrosis of the lower jaw.

How should phosphorus-poisoning be treated?

Copper sulfate is the chemical antidote; but as it is almost as dangerous as the phosphorus, *hydrogen dioxid* and *potassium permanganate* are much better and safer. All oils must be avoided, as these aid in the absorption of the phosphorus. Opium may be necessary to combat pain and irritation.

What are the symptoms and treatment of poisoning with bichlorid of mercury?

Bichlorid of mercury in toxic doses produces violent pain in the stomach, severe vomiting and purging of the contents of the bowel, mucus, and blood. The vomitus is white. Collapse, syncope, and death. If death does not occur at once, it is apt to do so later from the organic changes in the gastro-intestinal tract, such as strictures, sloughs, destruction of the peptic glands, and ulcerations.

Treatment: White of egg should be administered in large quantities as the chemical antidote; the stomach should then be evacuated by means of the stomach-pump. External heat and stimulants, such as ammonia, atropin, and strychnin, should be administered.

State the name and the alterative dose of a preparation of mercury capable of producing acute poisoning. Mention the chemical antidote for this preparation.

Hydrargyri chloridum corrosivum. Dose, $\frac{1}{100}$ to $\frac{1}{20}$ gr.
Egg-albumen.

Mention ten drugs, the use of any one of which may cause skin eruption.

Potassium iodid, copaiba, arsenic, cubebs, potassium bromid, chloral, quinin, belladonna, antipyrin, and mercury.

PRESCRIPTION WRITING

The dose of a medicine given by the mouth being 1 grain, what would be the equivalent dose for hypodermic use and what for administration by the rectum?

No definite rules can be given, as the absorbability of different drugs varies within wide limits. Roughly, the dose for hypodermic injection should be about three-fourths the dose by mouth, and the rectal dose twice as large. Opium is absorbed almost as completely when given by the rectum as when administered by mouth.

By what rule would you determine the dose of any medicine for a child?

Divide the age by the age + 12; the resulting fraction represents the proportion of the adult dose. For example, the dose for a child of three years is $\frac{1}{5}$ $\left(\frac{3}{3+12} \text{ or } \frac{3}{15}\right)$ of the adult dose.

What is meant by (a) endermic, (b) hypodermic, and (c) en= epidermic administration of a remedy?

(a) *Endermic* or *Endermatic.*—Application of a drug to a surface denuded of its epidermis by vesication. This method is painful and has gone out of use.

(b) *Hypodermic.*—Injection of a drug in solution into the subcutaneous areolar tissue.

(c) *Enepidermic.*—Application of a remedy in solution or ointment form to the skin *without friction.*

Write a prescription containing a stomachic to be used in alcoholism.

January 6, 1908.

For Mr. L. C. Thompson.

℞. Tincturæ nucis vomicæ,	fʒvj;
Tincturæ capsici,	fʒj;
Acidi hydrochlorici diluti,	f℥ss;
Tincturæ gentianæ compositæ,	q. s. ad f℥iij.—M.

Sig. One teaspoonful in water before meals.

G. W. Smith, M. D.

Write a prescription for diarrhea containing an alkali and an astringent suitable for a child of ten years.

January 6, 1908.

For Willie Jones.

℞. Bismuthi subnitratis,	ʒiij;
Sodii bicarbonatis,	ʒij;
Mucilaginis acaciæ,	f℥ss;
Syrupi simplicis,	f℥j;
Aquæ cinnamomi,	q. s. ad f℥iv.—M.

Shake the bottle.
Sig. One teaspoonful every three or four hours.

G. W. Smith, M. D.

Write a compound prescription for an adult containing iron, quinin, and opium in pill form for neuralgia.

January 15, 1908.

For Mr. A. B. Long.

℞. Pulveris opii,	gr. x;
Ferri carbonatis saccharati,	ʒiss;
Quininæ sulphatis,	ʒss.—M.

Fnt. pilulæ No. xxx.
Sig. One pill three times a day after meals.

G. W. Smith, M. D.

Write a prescription for a general tonic with tincture of nux vomica and a preparation of arsenic.

January 15, 1908.

For Mrs. Charles Brown.

℞. Tincturæ nucis vomicæ,	fʒvj;
Acidi hydrochlorici diluti,	fʒss;
Arseni trioxidi,	gr. $\frac{2}{3}$;
Vini pepsini,	f℥iv.—M.

Sig. One teaspoonful three times a day after meals.

G. W. Smith, M. D.

Write a prescription containing oil of sandalwood and at least one other constituent for chronic cystitis.

January 20, 1908.

For Mr. C. R. Stone.

℞. Olei santali,	fʒiss;
Hexamethylenamin,	ʒiss.—M.

Fnt. capsulæ No. xx.
Sig. One capsule three times a day after meals.

G. W. Smith, M. D.

Write for an adult a complete prescription for a diuretic containing not less than three ingredients.

January 10, 1908.

For Mr. C. R. Green.

℞. Potassii acetatis,
Potassii citratis,
Potassii bitartratis, āā ʒiss;
Aquæ, q. s. ad f℥vj.—M.
Sig. One tablespoonful in half a tumbler of water three times a day.

G. W. Smith, M. D.

Write a prescription containing a sedative and an expectorant for a bronchial cough in a three-year-old child.

January 15, 1908.

For Marjorie Jones.

℞. Ammonii carbonatis, gr. xx;
Tincturæ opii camphoratæ, fʒss;
Misturæ glycyrrhizæ compositæ, q. s. ad f℥iij.—M.
Sig. One teaspoonful every three hours.

G. W. Smith, M. D.

Write a prescription containing the tincture of the chlorid of iron and the chlorate of potash, with the proper dose for a child four years old.

January 10, 1908.

For John Brown.

℞. Potassii chloratis, gr. xij;
Tincturæ ferri chloridi, fʒj;
Glycerinæ, f℥ss;
Syrupi simplicis,
Aquæ, āā q. s. ad f℥iij.—M.
Sig. One teaspoonful in water every four hours.

G. W. Smith, M. D.

Write a prescription for a cough-mixture containing muriate of ammonia and an opiate, giving adult dose.

January 1, 1908.

For Joseph Wilson.

℞. Ammonii chloridi, ʒiij;
Tincturæ opii camphoratæ, fʒv;
Syrupus pruni Virginianæ, f℥iv.—M.
Sig. One teaspoonful every four hours.

Joseph Jones, M. D.

Write a prescription for (a) a collyrium, (b) a suppository, and (c) a mouth-wash.

(a) ℞. Acidi borici, gr. x;
Aquæ camphoræ,
Aquæ destillatæ, āā q. s. ad f℥j.—M.
Sig. Fifteen drops in both eyes thrice daily.

(b) ℞. Pulveris opii, gr. j;
Iodoformi, gr. j;
Olei theobromatis, q. s.—M.
Ft. suppositorium No. I.
Sig. Use on retiring.

Or—

℞. Ichthyol, ℥ss.
Olei theobromatis, q. s.—M.
Fnt. suppositoria No. xx.
Sig. One suppository at bed-time and after going to stool.

(c) ℞. Potassii chloratis, gr. lxxx;
Aquæ laurocerasi, f℥viij.—M.
Sig. Use as mouth-wash.

Write a complete prescription containing at least three drugs for acute bronchitis in an adult. Use no abbreviations.

January 15, 1908.

For Mr. T. L. Wilson.

℞. Ammonii chloridi, ʒiss;
Heroinæ hydrochloridi, gr. ij;
Balsami Peruviani, fʒj.—M.
Fiant capsulæ No. xxiv.
Sig. One capsule every four hours.

G. W. Smith, M. D.

Write a correct prescription containing nitrate of silver.

January 10, 1908.

For Mr. Thomas Jones.

℞. Argenti nitratis, gr. iij;
Pulveris opii, gr. ij.—M.
Fnt. pilulæ No. xii.
Sig. One pill three times a day before meals.

G. W. Smith, M. D.

Write a prescription containing some preparation of iron in a delectable form.

January 10, 1908.

For Mr. Thomas Turner.

℞. Strychninæ sulphatis, gr. j;
Liquoris ferri et ammonii acetatis, f℥iv.—M.
Sig. Two teaspoonsful in water three times a day after meals.

G. W. Smith, M. D.

Write a prescription for a syphilitic adult containing corrosive sublimate and iodid of potassium in solution.

January 20, 1908.

For Mr. T. L. Brown.

℞. Hydrargyri chloridi corrosivi, gr. j;
Kalii iodidi, ℥ss;
Elixir simplicis, f℥iv.—M.
Sig. One teaspoonful in water three times a day after meals.

G. W. Smith, M. D.

What is wrong with the following prescription?

℞. Argentæ nitratis, ʒj;
Sodi chloridum, ℥ss;
Syrupus lemonis, q. s. ℥iv.
Sig. Take a tablespoonful after meals in water.

This prescription contains a chemical incompatibility and several grammatical errors. Sodium chlorid combines with silver nitrate to form the insoluble and inert chlorid of silver. The grammatical errors are: argent*æ* instead of argen*ti;* sodi chloridum instead of sod*ii* chlori*di;* syrupus lemonis instead of syrúp*i* l*i*monis.

What are the standard units of the metric system of weights and measures?

1. The *meter*, the unit of length, is equal to $\frac{1}{40}$ millionth part of the earth's circumference. 2. The *liter*, or unit of capacity, equal to the cube of $\frac{1}{10}$ of a meter or a cubic decimeter. 3. The *gramme*, unit of weight, equal to the weight of 1 cubic centimeter of water at 4° Centigrade.

In prescription-writing the following units and subdivisions are used: the *gramme* (*Gm.*), equivalent to 15 or 16 grains (15.432); the *cubic centimeter* (*c.c.*), equivalent to the same number of minims. Centigramme (cg.) and milligramme (mg.) are seldom used, the quantities being expressed in decimal fractions of a gramme; thus, 2 cg. = .2 Gm.; 3 mg. = .03 Gm., etc. The symbols Gm. and c.c. are not written as a rule. A vertical line at the right of the prescription blank separates the grammes or cubic centimeters from fractional quantities, thus taking the place of a decimal point.

1 Gm. or c. c.	=	15 grains or minims.
4 " "	=	1 dram or fluidram.
30 " "	=	1 ounce or fluidounce.
500 " "	=	1 pint (Oj).

Write the following prescription in the metric system:

℞.	Strychninæ sulphatis,	gr. ss;
	Acidi hydrochlorici diluti,	f℥ss;
	Tincturæ cardamomi,	f℥ij;
	Tincturæ gentianæ compositæ, q. s. ad	f℥iij.—M.

Sig. One teaspoonful three times a day before meals.

℞.	Strychninæ sulphatis,		03	
	Acidi hydrochlorici diluti,	15		
	Tincturæ cardamomi,	8		
	Tincturæ gentianæ compositæ, q. s. ad	100		M.

Sig. One teaspoonful three times a day before meals.

Write the following prescription in the metric system:

℞.	Arseni trioxidi,	gr. ss;
	Strychninæ nitratis,	gr. ¾;
	Massæ ferri carbonatis,	ʒij.—M.

Fnt. pilulæ No. xxx.
Sig. One pill three times a day after meals.

℞.	Arseni trioxidi,		03	
	Strychninæ nitratis,		045	
	Massæ ferri carbonatis,	8		M.

Fnt. pill No. xxx.
Sig. One pill three times a day after meals.

Write a prescription for a patient suffering from cystitis with ammoniacal urine.

℞. Ammonii benzoatis, ʒij.
Pone in capsulas No. xxiv.
Sig. Two capsules every 3 hours.

Write a formula for the following: coryza, gastralgia, laryngitis, acute articular rheumatism, and delirium tremens.

Coryza:

℞. Extracti belladonnæ fol.,	gr. j;
Pulvis camphoræ,	gr. vj;
Quininæ hydrochloridi,	gr. vj.—M.

Fiant pilulæ No. xii.
Sig. One pill every hour.

Gastralgia:

℞. Cocainæ hydrochloridi,	gr. iss;
Acetanilidi,	gr. xxiv.—M.

Pone in capsulas No. xii.
Sig. One capsule every hour until relief is obtained.

Laryngitis:

℞. Tincturæ benzoini compositæ,	℥ij.

Sig. ʒij in one pint of boiling water and use by inhalation.

Acute articular rheumatism:

℞. Sodii salicylatis,	gr. clx;
Sodii bicarbonatis,	
Sodii bromidi,	āā gr. lxxx;
Syrupi aurantii,	℥iv;
Aquæ destillatæ,	ad ℥iv.—M.

Sig. ʒij in half glass of water every two hours.

Delirium tremens:

℞. Chloralis hydrati,	ʒij;
Sodii bromidi,	ʒiv;
Syrupi lactucarii,	ʒiv;
Aquæ destillatæ,	ad ℥iij.—M.

Sig. ʒj in water every two hours.

Write a complete prescription for a child of three years suffering with pertussis.

℞. Antipyrinæ,	gr. xvj;
Sodii bromidi,	gr. xlviij;
Tincturæ belladonnæ foliorum,	♏xvj;
Aquæ destillatæ,	ad ℥ij.—M.

Sig. ʒj in water every two hours.

Prescribe a local application for erysipelas, for rhus toxicodendron poisoning. Name some remedies used for epistaxis, croup, singultus, and ptyalism. Write a prescription for the night-sweats of phthisis, for ascites.

Erysipelas:

℞. Ichthyol,	ʒiv;
Adipis benzoinati,	
Adipis lanæ hydrosi,	āā q. s. ad ℥ij.—M.

Sig. Apply on lint to affected part.

Rhus poisoning:

℞. Liquoris plumbi subacetatis,	℥j;
Aquæ destillatæ,	q. s. ad Oj.—M.

Sig. Apply locally to affected part p. r. n. (Poison—shake well.)

Epistaxis:
Tannic acid, Monsel's solution, alum, acetanilid.

Croup:
Syrup of ipecac as emetic, antipyrin, sodium bromid, inhalations of steam.

Singultus:
Hoffmann's anodyne, oil of amber, camphor, counterirritation to abdomen.

Ptyalism:
Atropin internally, tannic acid locally as mouth-wash.

Night-sweats of phthisis:

℞. Acidi camphorici, ʒij.

Pone in capsulas No. xij.
Sig. One capsule one hour before retiring.

Ascites:

℞. Magnesii sulphatis (sol. sat.), ℥iv.

Sig. ʒij every hour.

ORGANOTHERAPY

Name the official digestive ferments; give their physiologic actions and therapeutic uses.

Pepsin and pancreatin. Their actions and uses are to aid gastric and intestinal secretion.

Compare the therapeutic uses of pepsin and pancreatin. How are these remedies prepared?

Pepsin is the digestive ferment of the gastric juice. In an *acid medium* it acts upon the proteins, converting them first into hemi- and anti-albumoses, then into hemi- and antipeptones. It is employed in gastric indigestion depending upon faulty secretion. It is also used for digesting false membranes and for coagulating milk. Pepsin is *prepared* by macerating the mucous membranes of hogs' stomachs in water acidulated with hydrochloric acid, clarifying by standing, and decanting. Sodium chlorid is then thoroughly mixed with it. The pepsin floats to the surface, and is removed and purified by redissolving in acidulated water and reprecipitating.

Pancreatin is a mixture of enzymes, viz.: trypsin, steapsin, and amylopsin, naturally existing in the pancreas of warm-blooded animals—usually obtained from the fresh pancreas of the hog. Pancreatin, unlike pepsin, acts in an *alkaline medium.* The *amylopsin* converts starch into glucose, the *steapsin* emulsifies and splits up fats, *trypsin* converts proteins into peptones, and, unlike pepsin, forms leucin and tyrosin. It is employed in intestinal indigestion, lienteric diarrhea, diabetes mellitus, and for peptonizing foods.

Describe the therapeutic uses of ox-gall.

Ox-gall is an intestinal antiseptic, preventing putrefactive changes in the bowel. It acts also as a cathartic by stimulating peristalsis; also as an aid to digestion, when deficient secretion of bile or faulty digestion of fats is present.

FOODS

What are the therapeutic uses of alcohol?

Locally applied, alcohol is a refrigerant, antiseptic, rubefacient, and slightly anesthetic. It is used as a wash or evaporating lotion over bruises, inflamed joints, and wounds of a contused character, and accompanied by friction to stimulate the skin to greater activity.

Internally, alcohol is primarily a stimulant to the nervous system, increasing the rapidity of thought and the reflex activity of the spinal cord, muscles, and nerves. It is also a stimulant to the heart, respiration, and vasomotor center. It lowers temperature by increasing heat-radiation. It aids digestion and is rapidly absorbed, destroyed, or eliminated. It is used as a *stimulant* to tide over critical periods during the course of acute infectious diseases, such as pneumonia and typhoid fever. Also in cardiac failure, syncope, snake-bites, and surgical shock. It is also used with cracked ice to allay vomiting, and in excessive wasting due to prolonged suppuration. It adds force, but not tissue, to the body. The question whether alcohol is a food is still under dispute.

Describe the therapeutic uses of olive oil and state where it is principally produced.

Olive oil is an *emollient*, being soothing and protective when applied to the skin and mucous membranes. It has considerable *nutritive* value when taken internally, and also slightly when applied externally in connection with massage. It is slightly *laxative*.

Olive oil is principally produced in Spain and Italy.

What alteration would you make in modified milk to overcome constipation?

Add as a diluent oatmeal-water instead of plain water and increase the percentage of cream.

Describe the manner of making barley-water as food for the patient.

Put two good-sized teaspoonfuls of washed pearl barley with one pint of cold water in a saucepan; boil slowly down to two-thirds, add salt, and strain.

From what is koumiss made and what are its therapeutic uses?

Koumiss is milk artificially prepared by simultaneous lactic acid and alcoholic fermentation. It was originally made by the natives in the steppes of southeastern Russia and other eastern countries by the fermentation of mares' milk. It can be *prepared* by adding to one pint of cool, perfectly fresh milk two teaspoonfuls of sugar and one-sixth of a cake of compressed yeast; the bottle is tightly corked, and kept in a warm place or in a water-bath at 99° to 100° F. for eight to ten hours, after which it is placed on ice.

Koumiss is an *easily digested food*, suitable for children and adults. It is useful in phthisis, chronic bronchitis, chronic gastro-intestinal catarrh, and other wasting diseases. It is also valuable in obstinate gastric irritation and severe vomiting. The so-called *koumiss cure* consists in administering large quantities daily in combination with nourishing albuminous food.

PHYSIOLOGIC THERAPEUTICS

Give the modes of applying the hot pack, and state the indications for its use.

A bed is prepared by covering it with a rubber sheet. Over this is placed a dry woolen blanket. A large, heavy blanket is now dipped in very hot water and wrung out; the naked patient is quickly wrapped in it, several hot-water bottles are placed alongside the body, and the dry blanket folded over. Finally, the sides of the rubber sheet are drawn around and over the patient and an ice-cap placed on the head. The temperature should be taken every half-hour, and if the patient becomes febrile (101° F.), he should be taken out and rubbed dry. Ordinarily the bath should last about *one hour*, and, if sweating does not rapidly occur, a glass of cold water should be given to drive the blood to the skin. A little gin or sweet spirits of niter may be added to the water. The hot-pack is *indicated* in uremia, and the various forms of nephritis and similar conditions, when it is necessary to eliminate toxic material; also to relax muscle spasm, to relieve nervous excitement and nervous insomnia. It is particularly valuable in malignant chorea and may also be used in tetanus.

Give the methods and the therapy of cold-water treatment applied externally.

Cold water may be applied externally in the following ways: cold compresses, cold sponge, cold pack, sprinkle bath, drip-sheet, tub-bath, lance douche, rain, and nuchal douches.

Cold compresses are used for affecting local inflammations or congestions. The other methods are usually employed for their systemic effect. The *tub-bath* is used in febrile diseases, especially typhoid fever, and consists in immersing the patient in cold water, at such a temperature (65° to 70° F.) as will produce a well-marked reaction. Active friction must be continued during the bath to bring fresh quantities of heated blood to the surface. An ice-bag is applied to the head, and a stimulant administered, before and after, if necessary. The *cold sponge*, *cold pack*, or *sprinkle bath* may be administered for the same purpose. The *drip-sheet* is especially valuable, applied in the morning, for neurasthenia, and at night for insomnia depending upon faulty cerebral circulation. It does good by increasing the elimination of toxic material by the skin and kidneys, stimulates the vasomotor system, the general circulation, and the processes of oxidation and nutrition, lowers the temperature, and prevents chafing and bed-sores.

Define briefly but clearly serum therapy.

Serum therapy consists of the prevention and cure of certain acute infectious diseases by administering subcutaneously, or locally applied to mucous membranes, a blood-serum containing antitoxin or antimicrobic substances antagonistic to the toxins or to the specific micro-organisms themselves, also in administering in the same manner, but by means of other media than blood-serum, attenuated cultures or the toxins from such cultures.

What doses of antitoxin are used for a child five years old ill with diphtheria? What would be the prophylactic dose for the same child?

In laryngeal and in all severe cases from 1500 to 2000 units, to be repeated in from eighteen to twenty-four hours if there is no improvement; a third dose after a similar interval, if necessary.

Prophylactic dose, 1000 units.

What are the therapeutic uses of sodium chlorid?

It is administered by hypodermoclysis, intravenously, or by the rectum, in the form of physiologic or *normal salt solution* containing 0.6 per cent. sodium chlorid, after profuse hemorrhage, the abstraction of large quantities of fluid from the body, in anemia, shock, and acute infectious diseases, to dilute and aid the elimination of toxic material. In the form of the *salt bath* it is used to stimulate the skin and as a general tonic.

What is the strength of normal salt solution? Give indications for its use and mode of administration.

Six-tenths of 1 per cent.

Describe hypodermoclysis and state the circumstances under which it is practised as a therapeutic measure.

Hypodermoclysis is the gradual introduction of fluid in considerable quantity into the subcutaneous tissues of the thigh, abdomen, or breast. The sterile fluid is placed in a sterile irrigation jar or rubber bag, to which air gains access only by means of a glass tube filled with sterilized cotton. From the lower part of the vessel leads a rubber tube to which is attached a needle or cannula, also rendered sterile. The flow is controlled by a pinch-cock upon the rubber tube. The vessel is placed 2 or 3 feet above the patient. The selected area having been *thoroughly sterilized,* the needle is introduced and the fluid allowed to enter quite slowly. A tumor of considerable size forms, but soon subsides, its disappearance being hastened by gentle rubbing. It is not safe to infuse a greater quantity of liquid than 1 dr. to each pound of body-weight in fifteen minutes.

Hypodermoclysis is *employed* after hemorrhage in the collapse of cholera, in uremia, pneumonia, septicemia, surgical shock, and diabetic coma. It is also useful in severe burns to overcome shock and toxemia.

Describe the method of applying leeches.

Leeching is a method of abstracting blood for the purpose of relieving local inflammation or acute congestion. The selected area is thoroughly cleansed. The leech is then placed under an inverted glass or under a large pill-box to prevent it from migrating before it takes hold. A little sweetened milk, or a drop of blood extracted from the finger, may be placed upon the skin where the leech is to be applied. When the leech has taken enough blood, it can be removed by sprinkling with salt or alcohol. Leeches secrete a liquid which prevents coagulation of the blood. If continued bleeding occurs, styptics and a compress are to be applied. Leeches leave a small permanent triangular scar; hence they should not be placed upon the face or other exposed surface.

For what conditions should blisters be applied? Describe the application of blisters.

Blisters are applied for their *counterirritant* effect. They are, therefore, useful in the presence of inflammations or congestions, for causing absorption of inflammatory exudate, for the relief of pain, and for the effect which can be exerted upon the general system in systemic diseases.

The skin is thoroughly cleansed and rubbed vigorously to produce slight hyperemia; a little vinegar is now applied and finally the blistering agent, usually cantharides plaster. As its action is reflex, it should be applied some little distance from an acutely inflamed area.

Describe the technic of venesection.

The patient assumes the semi-erect or recumbent posture, as the case demands. The arm is abducted, extended, and rotated outward. The parts are asepticized and a tape is tied around the arm just above the elbow. The surgeon stands to the right of the arm and holds the elbow in his left hand, placing his thumb upon the vein below the intended point of puncture. The patient grasps a stick firmly and works his fingers in order to cause the veins to distend. Either the median cephalic or median basilic may be opened. The median basilic is the more distinct, and is the vein usually selected. In opening the vein, do not cut too deep, as nothing but the bicipital fascia separates it from the brachial artery. The median cephalic may be selected (we thus avoid endangering the brachial artery); under this vein lies the external cutaneous nerve. Steady the vein with the thumb and open by transfixion, making an oblique cut which divides two-thirds of the vessel. Remove the thumb and allow the bleeding to go on, instructing the patient to work the fingers. Carefully watch the pulse; when faintness begins, remove the fillet, put an antiseptic pad over the puncture, apply a spiral reversed bandage of the hand and arm and a figure-of-eight bandage of the elbow, and place the arm in a sling for several days.

PRACTICE OF MEDICINE

GENERAL DIAGNOSIS

What diseases produce conditions of the skin which are of general diagnostic value?

Diseases of the skin, the exanthemata, diseases of the liver, yellow fever, purpura, Addison's disease, argyrosis, and myxedema.

Give the causes of vertigo.

Any circulatory disturbance of the brain: anemia in valvular heart disease; edema of the brain in nephritis. Diseases of the blood-vessels: arteriosclerosis, aneurysm, apoplexy, cerebral embolism, or thrombosis. Diseases of the stomach and liver. Nervous disorders: epilepsy. Reflex causes: refractive errors. Disease of Eustachian tubes, auditory nerve, and labyrinth; laryngeal disease. Ménière's disease (paroxysmal aural vertigo).

Differentiate between cerebral vomiting and gastric vomiting.

In *cerebral vomiting* the contents of the stomach are suddenly and violently expelled without cause, pain, or retching, and without reference to the taking of food; the pulse is slow and full. *Gastric vomiting* is preceded by nausea and epigastric pain and tenderness, and there are symptoms of some gastro-intestinal disorder; the pulse is apt to be hurried and feeble.

Describe four peculiar appearances of the tongue and give their significance in diagnosis.

1. *The Coated Tongue.*—The coating is continuous, consisting of an excess of epithelium on the papillæ; the degree of moisture varies. This is the tongue of acute febrile diseases, such as pneumonia and typhoid fever.
2. *The Strawberry Tongue.*—The fungiform papillæ appear like red points shining through the coating, especially at the tip and edges. Seen in scarlet fever.
3. *The Incrusted, Dry, Brown Tongue.*—The thick, felt-like coat, largely made up of parasites, is continuous and dips down between the papillæ. It is seen in the typhoid state, in cancer, and in phthisis.
4. The *red, dry tongue* indicates chronic wasting disease. It occurs in late phthisis, chronic diarrhea, dysentery, and liver abscess.

What is an endemic disease?

One that is continuously present in a given locality. 'Until 1901 yellow fever was endemic in Havana.'

In what cases would the ophthalmoscope aid in diagnosis?

In chronic interstitial nephritis, pernicious anemia, leukemia, diabetes, syphilis (*retinitis*); in valvular heart disease, especially aortic lesions (*visible pulsation of retinal arteries*). *Optic neuritis* may be present in the same conditions, or may indicate tumor.

In what diseases can we employ the microscope to advantage as an aid in diagnosis?

In tuberculosis (*tubercle bacillus in sputum*); typhoid fever (*Widal's agglutination test in blood*); gonorrheal infections (*Neisser's gonococcus in urethral discharge*); malaria (*parasites in blood*); amebic dysentery (*amebæ in stools*); diseases due to intestinal parasites; diseases of the blood and kidneys.

In what conditions does subnormal temperature occur?

During convalescence from febrile diseases; in wasting diseases (cancer, tuberculous peritonitis), starvation, anemia; in myxedema and occasionally in diabetes; in cerebral abscess. Sudden fall of temperature denotes collapse and occurs after shock, in hemorrhage, apoplexy, cerebral and pulmonary thrombosis or embolism; in cholera Asiatica; after the crisis in pneumonia; after perforation in typhoid fever.

What are the grades of temperature that come under observation in the sick?

The temperature of collapse—below 96° F.; subnormal temperature—from 96°–97.5° F.; normal temperature—98.6° F.; subfebrile temperature—from 99.5° to 101° F.; moderate fever—from 101° to 103° F.; high fever—from 103° to 105° F.; hyperpyrexia—above 105.5° F.

Of what import is the spleen in the diagnosis of febrile conditions? Give the topography of the spleen.

Splenic enlargement occurs in infectious febrile conditions, notably in *malaria* and *typhoid fever*. The *splenic dulness* extends between the ninth and eleventh ribs in the middle and posterior axillary lines.

What is dysphagia, and with what pathologic conditions is it associated?

Dysphagia is difficult swallowing. It may be due to—(1) *Disease of the mouth and fauces:* glossitis, cancer of the tongue, and the various forms of stomatitis; pharyngitis and tonsillitis, rheumatism of pharynx, retropharyngeal abscess (quinsy); certain infections: scarlet fever, diphtheria, and variola. (2) *Disease of the larynx:* edema, inflammation or ulceration (tuberculosis, malignant disease), anesthesia (in central nervous diseases). (3) *Disease of the esophagus:* paralysis (late diphtheria); spasm, stricture (traumatism, cancer, syphilis); external pressure (enlarged mediastinal glands, tumors, aortic aneurysm, pericardial effusion); foreign body in esophagus.

What is the practical import of hematuria and how can its source be diagnosed?

Hematuria is a symptom of disease of the kidneys, bladder, or urethra. It is constant in renal calculus. *Blood from the kidney* is intimately mixed with the urine, which is of a reddish-brown color and usually contains casts and renal epithelium. The red blood-cells are found singly, and are pale yellow from having lost their hemoglobin. *Hemorrhage from the bladder* is usually more copious, the blood is not intimately mixed with the urine, which, upon standing, shows fibrin. Micturition is frequent and accompanied by pain. In calculus or tumor of the bladder the hematuria is intermittent. In lesions of the urethra or neck of the bladder only the last few drops are bloody.

Give the method for the detection of the tubercle bacillus in the sputum.

Select a small yellow nodule from the specimen and spread uniformly and as thinly as possible on a clean slide; dry in the air; fix by passing the slide through the flame three times, and stain by Gabbet's method, as follows: (1) Cover the smear with Ziehl's solution (fuchsin, 1 gr.; alcohol, 10 cc.; 5 per cent. solution carbolic acid, 100 cc.) and heat gently for two minutes, adding the stain as required. (2) Wash in water and immerse for from a half to one minute in Gabbet's (decolorizing) solution (methylene-blue, 2 gr.; 25 per cent. aqueous solution of sulfuric acid, 100 cc.). Wash in water, dry, and examine at once with a $\frac{1}{12}$ oil-immersion objective or mount in balsam. The tubercle bacillus is stained bright red; everything else is stained blue.

In what diseases does leukocytosis occur, and in what diseases is it absent?

Present (*leukocytes increased*).	*Absent* (*leukocytes normal or diminished*).
Pneumonia.	
Acute articular rheumatism.	Influenza.
Ulcerative endocarditis.	Typhoid fever.
Septicemia and pyemia.	Measles.
Pericarditis.	Miliary tuberculosis and other forms of pure tuberculous infection.
Appendicitis.	
Typhus fever.	Malaria.
Relapsing fever.	Pernicious anemia.
Asiatic cholera.	Splenic anemia.
Yellow fever.	The splenic form of Hodgkin's disease.
Bubonic plague.	
Cerebrospinal meningitis.	
Diphtheria.	
Scarlet fever.	
Septic meningitis.	
Tuberculous meningitis (sometimes).	

Mention and describe, in regard to the feces, abnormal conditions that are of diagnostic value.

Color.—Black, after hemorrhage in the gastro-intestinal tract and after the ingestion of iron or bismuth; *clay-colored*, from the absence of bile in diseases of the liver; *green*, in acute enteritis and enterocolitis.

Consistency.—Very hard, sometimes *scybalous* (lumpy), in obstinate constipation; *semiliquid* in mild intestinal catarrh; *liquid* in severe forms; watery, *rice-water stools* in Asiatic cholera.

Presence of Pus, Blood, and Mucus.—*Pus* points to the presence of an abscess in the intestinal tract, or very frequently to malignant disease of the rectum. *Blood*, if bright, is derived from hemorrhoids, or possibly an ulcer in the lower portion of the bowel. If intimately mixed with feces, the source of the hemorrhage is higher up, usually in the small intestine. *Mucus* indicates a chronic catarrhal condition of the intestine; it may be present in small masses or in large membranous shreds; it is always derived from the large intestine.

Parasites.—The proglottides of *tapeworm; round-worms*, *seat-worms*, and the like; the *ova* of these parasites. *Amœba coli* may be found.

Foreign Bodies.—*Gall-stones* and *enteroliths* are most important. Sometimes undigested particles of food are found, and indicate deficient gastric digestion.

Fat is discovered microscopically in globules and in tiny needles; it points to chronic intestinal catarrh and sometimes to disease of the pancreas.

What conditions might cause alvine discharges containing fat?

Overfeeding in infants; chronic catarrh of the small and large intestine; if the stools are clay-colored, obstruction of the bile-duct. Fatty stools are also found in disease of the pancreas.

What is hemoptysis?

Bleeding from the lungs.

Differentiate hemoptysis and hematemesis.

Hemoptysis.	*Hematemesis.*
1. Often preceded by cough or signs of pulmonary or cardiac disease.	1. Previous history of gastric, hepatic, or splenic disease.
2. Blood coughed up; vomiting, if it occurs, follows the cough.	2. Blood vomited.
3. Blood frothy, bright red, and alkaline; mucopus may be mixed with it.	3. Blood dark, usually clotted, mixed with food and acid.
4. Cough persists, with signs of local disease in chest; sputa continue to be blood-stained.	4. The hemorrhage is followed by tarry stools, and signs of abdominal disease may be detected.

In what diseases may blood be expectorated?

In pulmonary tuberculosis; croupous pneumonia (*rusty sputum*); hemorrhagic infarct; abscess, gangrene, and cancer of the lungs; plastic bronchitis; valvular heart disease, especially mitral stenosis; aneurysm; gout (endarteritis); diseases of the blood: hemophilia, scurvy, purpura, and anemia. Hemoptysis sometimes occurs during menstruation, or vicariously for the menstrual flow, and during the menopause.

What is the diagnostic significance of dropsy?

General dropsy—*anasarca*—points to cardiac or renal disease; *cardiac dropsy* usually begins in the feet, spreads slowly to other portions of the body, and is accompanied by cyanosis; *renal dropsy* often begins in the

face, and the color of the skin is waxy. General dropsy also occurs in anemia (hydremic dropsy) and in toxemias.

Local edema may be due to obstruction of, or pressure on, lymphatics or veins; inflammation and suppuration ('collateral edema'); injuries or disease of nerves (neuritis, angioneurosis); vasomotor ataxia (angioneurotic edema). Edema of the face is a symptom of trichinosis. Dropsy also occurs in beri-beri.

PHYSICAL DIAGNOSIS

What are the methods of physical diagnosis or exploration?

Inspection, palpation, percussion, and auscultation. Auxiliary methods: mensuration and succussion.

Define cyanosis and give its causes.

Blueness of the skin from insufficient oxygenation of the blood. *Causes:* chronic heart disease with failing compensation; pulmonary tuberculosis; any condition that obstructs or occludes the air-passages and prevents the free entrance of air: spasm and edema of larynx; croup; foreign bodies in air-passages; emphysema; pneumonia; paralysis or spasm of respiratory muscles.

Define vocal fremitus and state its significance in pulmonary disease.

The transmission to the palpating hand of the vibrations produced during phonation in the bronchial tubes. The vocal fremitus is *increased* by solidification; hence in pneumonia, tuberculosis, pulmonary infarct, and tumor. It is increased over a cavity and in the compressed lung above a pleural effusion. Vocal fremitus is *diminished* in the presence of a pleural effusion or a thickened pleura; in asthma and emphysema; over a cavity filled with fluid; and whenever a large bronchus is occluded.

Describe the essentially different sounds given by the thorax on percussion.

Resonance, elicited over healthy lung tissue; *tympany*, over the trachea; *dulness*, over the heart; *flatness*, over the liver.

What are the physical signs of pulmonary solidification?

Increased vocal fremitus and vocal resonance, a dull percussion-note, and bronchial breathing. In *pneumonia* crepitant and, after resolution has begun, moist râles are present.

In auscultation of healthy lungs what sound is heard and what is it technically termed?

The normal respiratory sound, known as *vesicular breathing*.

Describe three pathologic pulmonary sounds heard on auscultation, and give their significance in diagnosis.

Bronchial breathing indicates solidification and is heard in lobar pneumonia and in tuberculosis. It is heard normally over the trachea.

Crepitant râles, heard in first and third stages of lobar pneumonia, in pulmonary edema, and in some stages of tuberculosis.

Pectoriloquy, transmission of whispered or spoken words to the auscultating ear; heard over a cavity communicating with a bronchus and over solidification.

In what conditions does bronchial breathing take the place of vesicular breathing?

In any condition involving partial or total obstruction of lung tissue; hence, in infiltration and solidification. It is also heard over small cavities.

What is the significance of prolonged expiration?

(1) Emphysema; (2) bronchitis, with partial obstruction of tubes from swelling of mucous membrane or the presence of secretions; (3) beginning infiltration in the early stage of tuberculosis (apices); (4) bronchial or spasmodic asthma (accompanied by sibilant and sonorous râles).

Define a puerile murmur and give its causes.

Puerile breathing is louder than normal vesicular breathing, and expiration is higher pitched and almost as long as inspiration. It is normal in children. In *disease* it is heard chiefly over lung tissue that is doing extra work (compensatory emphysema), and occasionally in cases of heart disease.

Differentiate between sibilant and sonorous râles.

The difference relates to *pitch* and depends on the size of the bronchial tubes in which the râles are produced. *Sibilant* râles originate in the smaller tubes and are high pitched and whistling in character; *sonorous* râles are louder and lower in pitch, coming from the larger bronchi.

Differentiate the crepitant râle and the subcrepitant râle and give the clinical significance of each.

The *crepitant* râle is a fine, moist râle caused by the sudden inflation of pulmonary alveoli agglutinated by exudate. It is localized and is heard at the end of inspiration. It is generally considered pathognomonic of the early stage of croupous pneumonia and of pulmonary edema, and is heard also in tuberculosis. *Subcrepitant* râles resemble the former, but are larger, and the element of moisture is more pronounced. They may be general or local, and are produced in the alveoli and in the smaller bronchioles. When *general*, they indicate the presence of fluid in the finer bronchioles, as in congestion, edema, hemorrhage, or bronchitis. *Localized* subcrepitant râles are heard in phthisis, in the collateral edema of pneumonia, in bronchopneumonia, and in the third stage of croupous pneumonia.

Give the area of normal heart dulness. What conditions increase the area of heart dulness?

Absolute or deep cardiac dulness.

Above: fourth rib.

Below: sixth rib, merging into liver dulness.

Right border: left edge of sternum from upper border of fourth rib downward.

Left border: line from fourth left chondrosternal junction to a point midway between the parasternal and mammary lines in the fifth interspace (Musser).

Relative or superficial dulness.

Above: third rib.

Below: sixth rib, merging into liver dulness.

Right border: one finger's-breadth to the right of the right border of the sternum.

Left border: curved line from the third rib above to the apex-beat.

Describe the natural heart-sounds.

The *first* or *systolic* sound is duller, longer, and lower in pitch than the *second, diastolic* sound, which is short, clear, and valvular. The first sound is separated from the second by a short interval, and the second from the succeeding first by a longer interval. The first sound is synchronous with the apex-beat and is due to the impact of the heart against the chest-wall, contraction of the ventricles, and tension and vibration of the auriculo-ventricular valves. The second sound is generally attributed to closure of the aortic and pulmonary valves. It is heard best over the base of the heart.

Differentiate cardiac hypertrophy from cardiac dilatation.

Hypertrophy.	*Dilatation.*
Apex-beat displaced downward (sixth or seventh interspace) and to the left.	Apex-beat displaced to left, but rarely downward. Defined with difficulty. Area of impulse diffuse and wavy. Pulsations may be seen and felt along the sternum.
Impulse slow, forcible, and heaving.	Impulse quick, but weak.
Dulness increased both upward and transversely.	Increase of dulness more transverse; apex rounded or square.
First sound prolonged and dull; second sound clear and loud (accentuated).	First sound short and sharp; second sound feeble and sometimes reduplicated. A systolic murmur may be present (relative insufficiency).
Pulse full, regular, and strong; tension increased.	Pulse small and soft, often irregular. Embryocardia and gallop rhythm may be present.

What are hemic murmurs as applied to the heart, and what is their cause?

Hemic murmurs occur in anemia and chlorosis, and are held to be due to some alteration in the constitution of the blood and to diminished blood-pressure. They are practically always systolic, soft, and blowing, heard at or near the pulmonary cartilage, and not transmitted.

Differentiate organic and functional heart murmur.

Organic.	*Functional.*
May be systolic, presystolic, or diastolic.	Practically always systolic.
Heard at points of maximum intensity and transmitted in definite directions.	Heard at the base, especially pulmonic area; not transmitted.
Variable in character.	Almost always soft and blowing.
Thrill sometimes present (obstructive murmurs).	Thrill not present.
Signs of hypertrophy or dilatation, or both.	Not present. Anemia common.

Describe the mitral regurgitant murmur. Give the topography of the chest, showing where this sound is best heard.

A *systolic* murmur, heard best at apex and transmitted to axilla and angle of scapula. Usually soft and blowing; may be rough, high-pitched, or even musical.

State where topographically mitral and tricuspid murmurs are most distinctly heard.

Mitral regurgitant, in mitral area.
Mitral stenotic, at or just inside position of apex-beat.
Tricuspid regurgitant, at or a little to the right of ensiform cartilage.
Tricuspid stenotic, same situation as mitral stenotic.

Describe the characteristics and significance of the several kinds of arterial pulse.

Normal: regular, 70 to 80 a minute in the adult; moderately full and strong.

Intermittent: loss of one or several beats at regular or irregular intervals. May be normal; occurs in tobacco-heart, fatty degeneration, and 'weak heart.'

Irregular, both in rhythm and volume: common in myocarditis and in mitral lesions.

Bigeminal and *trigeminal:* two or three beats followed by a longer pause. Same significance as irregular.

Corrigan: short, quick, and receding; characteristic of aortic regurgitation.

Dicrotic: the main beat is followed by a secondary beat or wave; indicative of low tension and seen in asthenic fevers, especially typhoid.

Pulsus paradoxus: the pulse is suppressed at the end of inspiration; observed in adherent pericardium.

DISEASES OF THE RESPIRATORY ORGANS

How should acute coryza be treated?

Inhalation or local application of menthol in oily solution; weak (4 per cent.) solution of cocain may be used with caution. Internally, a saline laxative, then Dover's powder and quinin (5 gr. of each), three times a day.

Describe a typical case of laryngismus stridulus.

The attack usually occurs at night and wakes the child from sleep; the breathing suddenly stops, the face becomes pale and then cyanotic, the eyes are turned up, there may be general tonic convulsions. After an interval varying from a few seconds to twenty or more the spasm suddenly relaxes, and a long, shrill, crowing inspiration ends the attack.

How should edema of the larynx be treated?

Free catharsis; application of blisters or leeches over the larynx; spraying with astringent solutions (tannic acid or alum). If these measures fail, scarification, intubation, or tracheotomy as a last resort.

Give the physical signs of pleuritic effusion.

Inspection: Enlargement of affected side: bulging of interspaces; diminished movement; displacement of apex-beat.

Palpation: Decrease or absence of vocal fremitus.

Percussion: Dulness or flatness, with greatly increased resistance to pleximeter finger; change in upper level of dulness with change of position; hyperresonant note (*Skodaic resonance*) above effusion; impaired resonance and bronchial breathing near spine on affected side (compression of lung against vertebræ).

Auscultation: Diminution or absence of breath-sounds; egophony at angle of scapula (above level of effusion); sometimes bronchial breathing, especially in children.

Mensuration may show a larger semicircumference on the side of the effusion.

How may pleuritis in its early stages be differentiated from intercostal neuralgia?

The pain in *pleuritis* is accompanied by cough, aggravated by deep breathing, and relieved by immobilizing the chest; in *intercostal neuralgia* the pain is associated with tenderness at the points of exit of the intercostal nerves, and is not increased by breathing. Fever and friction sound are absent in neuralgia. *Herpes zoster* may accompany the latter.

How may pleuritic friction sounds be distinguished from rales occurring in the bronchial tubes?

Friction sounds are localized at the seat of pain and superficial (heard close to the ear). Pressure with the stethoscope increases the sound, which is heard at the end of inspiration and sometimes at the beginning of expiration, and is usually unaffected by cough and deep breathing. The sound is constantly present until effusion takes place. *Bronchial râles* appear to be deeper, are not accompanied by pain, longer in duration, and more widely diffused over the chest.

Differentiate empyema from pulmonary abscess.

The differential diagnosis is most difficult between a lobular empyema and abscess. In *empyema*, in addition to the physical signs of pleural effusion, displacement of the heart is more common, and the skin is often edematous. Fremitus and vocal resonance are absent. *Pulmonary abscess* presents the physical signs of a *cavity*, surrounded by solidified tissue. The sputa are copious, purulent, odorless, or offensive, and may contain elastic fibers. Leukocytosis may be present in both conditions; the temperature-curve is more septic in type in empyema.

Describe the treatment of pleurisy with effusion.

Saline purges, salicylates, and diuretics; counterirritation with blisters or cups; aspiration.

Describe the treatment of purulent pleurisy.

Simple incision between two ribs, usually the seventh and the eighth, in the postaxillary line; or resection of one or two ribs, followed by complete evacuation of the pus and fibrin masses. Irrigation should not be used.

Name the leading rational and physical signs of chronic bronchitis.

Rational signs: Cough, with or without expectoration; substernal pain, and sometimes cyanosis and dyspnea. The *physical signs* are moist or dry râles and, in chronic cases, the signs of *emphysema:* enlargement of the anteroposterior diameter of the chest, hyperresonance, diminution of cardiac dulness, and prolonged expiration.

Define and describe bronchorrhea.

The secretion may be very watery (*bronchorrhœa serosa*) or purulent, but thin; sometimes it is thick and ropy. The condition is a manifestation of chronic bronchitis, and may lead to bronchiectasis or may persist for years without impairing the general health.

Give the causes and treatment of bronchial, spasmodic, or essential asthma.

Causes.—*Predisposing:* heredity, neurotic or gouty diathesis, disease of the nose. *Exciting:* inhalation of dust or pollen; odor of certain animals, reflex irritation in various parts of the body, the nose, gastro-intestinal canal, skin.

Treatment.—To relieve the attack, inhalation of asthma-powders containing niter, lobelia, and stramonium; amyl nitrite, ether, or chloroform. Niter-paper cigarettes. Dry cups or mustard plaster to chest. Internally, sedatives, as Hoffmann's anodyne, tincture of lobelia, or the bromids. Morphin ($\frac{1}{4}$ gr.) and atropin ($\frac{1}{100}$ gr.) may be necessary.

Constitutional treatment during interval: regulation of diet and hygiene; exercise, frequent sponging, change of climate. Medicinal: Fowler's solution, potassium iodid, nitroglycerin. Adrenalin ($\frac{1}{20}$ gr. every two or four hours) in triturates which are to be held in the mouth until dissolved, or incorporated in an ointment and applied to the nasal mucous membrane, acts well in many cases.

What would auscultation and percussion reveal in a case of congestion of the lung?

Auscultation: small moist râles, with bronchovesicular breathing; *percussion:* impaired resonance. The condition may be present without physical signs.

Mention the causes and describe the treatment of primary lobar pneumonia.

Causes.—Pneumococcus or Diplococcus pneumoniæ of Fraenkel, and Bacillus pneumoniæ of Friedländer. Exposure to cold and wet is usually given as the cause. Abuse of alcohol and a previous attack are predisposing causes.

Treatment.—There is no specific. Sponging or wet pack when the temperature rises above 103° F. Venesection at the beginning of the disease is recommended. Hot or cold applications may be made to the chest to relieve pain, but the latter often requires opium in severe cases. Cupping is indicated in the stage of congestion and to relieve pain. Digitalis and strychnin early, to prevent heart failure. Alcohol is required in most cases, and the diet should be liquid until the crisis has passed.

How would you diagnose pneumonia?

By the mode of onset with chill and vomiting; the continuously high temperature; the cough and expiratory 'grunt' and characteristic 'rusty sputum'; the dyspnea and cyanosis, sometimes flushing of the face on the side corresponding to the affected lung; the physical signs of solidification; the râles peculiar to the different stages; the presence of leukocytosis; the diminution or absence of chlorids in the urine.

What are the physical signs in the first stage of pneumonic fever?

Diminished movement of affected side, with general increase of respiration. *Palpation* shows some increase of fremitus. *Percussion-note* impaired or slightly tympanitic (*Skodaic resonance*). *Auscultation:* diminished or bronchovesicular breathing and crepitant râles.

Give the physical signs of the second stage of acute lobar pneumonia.

Great increase of fremitus and vocal resonance; dulness or flatness on percussion; bronchial breathing with a few moist subcrepitant râles, due to associated bronchitis.

Differentiate pleurisy and pneumonia.

In *pleurisy* there is a friction sound, heard commonly with both inspiration and expiration; fever is slight, and there is marked pain on breathing. There may be slight cough. In the first stage of *pneumonia* there is also some pleurisy, especially when the inflammatory exudate reaches the periphery of the lung. There are high fever, which is preceded by a marked chill; cough, with rusty sputum; and the physical signs (crepitant râles, dulness on percussion, bronchial breathing, and *crepitus redux*).

Differentiate acute bronchitis from croupous pneumonia.

By the absence of physical signs of solidification. The temperature is not so high and more irregular, the dyspnea is less, the pain is substernal instead of a 'stitch in the side.' The râles in bronchitis are at first dry and later change to moist or mucous, but crepitant râles are not heard.

Differentiate catarrhal from croupous pneumonia.

Catarrhal Pneumonia.	*Croupous Pneumonia.*
Usually secondary to bronchitis.	Primary. An acute infection due to a specific micro-organism.
Onset gradual, usually without chill.	Sudden onset with chill and vomiting, and, in children, convulsions.
Temperature moderate, irregular, not typical, terminating by lysis after indefinite duration.	Continuous, high fever, ending by crisis between the fifth and the ninth days.
Most common in the very old and very young.	Occurs at any age.
Bilateral.	Unilateral mostly.
Mucopurulent sputum.	'Rusty,' blood-streaked sputum.
Indefinite physical signs of disseminated areas of solidification.	Distinct physical signs of solidification of an entire lobe or lung, with characteristic progression toward resolution.
	Crepitant râles during the first stage, disappearing during stage of solidification and reappearing when resolution sets in.

Describe the symptoms and treatment of gangrene of the lung.

Symptoms.—Moderate fever, hemoptysis, expectoration of profuse, brownish, purulent sputum with characteristic gangrenous odor. The sputum separates into three layers and contains fragments of lung tissue, leukocytes, altered blood, fat-crystals, and bacteria. The physical signs are those of a cavity. Sometimes the condition is latent.

Treatment.—Inhalation of phenol, guaiacol, or other antiseptic may be tried. General supportive treatment. Surgical interference if the patient's condition permits.

Give the treatment of catarrhal pneumonitis.

The *hydrotherapeutic* treatment is most important—cool sponging to reduce temperature and as a general tonic. If cyanosis and coma develop, a warm bath with cool affusions to the chest and back. Inhalation of aqueous vapor medicated with compound tincture of benzoin. Inhalation of oxygen. Alcohol, strychnin, stimulating expectorants, and, if the child is strong, emetics (syrup of ipecac) from time to time. Mild purgation at intervals. Light and nutritious diet.

What adventitious sounds are usually discovered by auscultation in catarrhal pneumonia?

Bronchial or bronchovesicular breathing over scattered areas; sibilant or subcrepitant and also mucous râles.

Differentiate acute phthisis and capillary bronchitis.

The differential diagnosis must be based on the history, age, and general symptoms more than on physical signs, unless distinct signs of localized solidification or cavity are present, or sputum can be obtained and tubercle bacilli or elastic tissue are found. In capillary bronchitis the sputum is mucopurulent and may contain various micro-organisms, but not tubercle bacilli. Cough is more severe and cyanosis greater in capillary bronchitis.

Give the physical signs of a cavity of the lung in pulmonary tuberculosis.

Inspection: Flattening of the chest over the cavity. *Palpation:* Tactile fremitus increased. *Percussion:* If the cavity is empty, the note is tympanitic or amphoric, depending on the size of the cavity and its relation to the chest-wall. When the cavity communicates directly with a large bronchus, the so-called 'cracked-pot sound' is heard and the percussion note changes when the patient alternately opens and closes his mouth (Wintrich's change of sound). When the cavity is filled with exudate, the sound is dull. *Auscultation:* Over an empty cavity, increased vocal resonance and pectoriloquy; tubular, cavernous, or amphoric breathing. If the cavity contains fluid, bubbling râles are also heard.

What remedies should be used to control hemorrhage from mucous surfaces?

Opium, ergot, suprarenal gland preparations.

Mention the most reliable remedy for pulmonary hemorrhage.

A hypodermic injection of $\frac{1}{4}$ gr. of morphin.

What should be done for hemoptysis occurring in the course of phthisis?

Give a hypodermic injection of morphin, ¼ gr., at once. Keep the patient absolutely quiet; apply ice-bag or cold coil to chest, and prohibit ingestion of food and drink, except small pieces of ice to relieve thirst.

What is the character of the fever-curve in chronic tuberculosis?

Usually intermittent, sometimes continuous; sometimes the temperature is subnormal.

What measures should be adopted in the treatment of pulmonary edema?

Aside from the treatment of the primary disease, active catharsis and, if there is much cyanosis and dyspnea, venesection.

Describe the treatment of hydrothorax.

Saline purges and diuretics, with diaphoresis if not counterindicated by the general condition. If these fail, aspiration, repeated if necessary.

Give the etiology and treatment of hemothorax.

Etiology.—1. Traumatism: fracture of a rib, penetrating wound of the thorax. 2. Aneurysm. 3. Erosion of blood-vessels by cavities, caries of ribs, or morbid growth in the thorax (carcinoma).

Treatment.—Absolute rest, ice-bag or cold coil to chest, opium—in the hope of spontaneous recovery by absorption and clotting. Stimulation must be avoided. If dyspnea is extreme, aspiration or incision as a last resort.

DISEASES OF THE HEART AND BLOOD-VESSELS

What are the causes and treatment of palpitation of the heart?

Causes.—(a) Toxic substances: tobacco, coffee, and tea; (b) over-exertion (irritable heart of young soldiers); (c) nervous causes: hysteria, neurasthenia, and emotional disturbances; (d) failing compensation in valvular and myocardial disease; (e) anemia and chloremia; (f) reflex causes: indigestion, dilatation of stomach, and flatulence.

The *treatment* depends altogether on the underlying cause, which must be removed, if possible. Rest and an ice-bag applied to the precordia are useful measures in most cases.

Give the most frequent causes of pericarditis.

Rheumatism and chorea, septicemia, scarlet fever, traumatism.

Give the physical and rational signs of pericarditis, before and after effusion.

Pain, usually in the fourth or fifth interspace; rapid pulse, out of proportion to the moderate fever; sometimes dyspnea. Friction sound, to-and-fro, not transmitted, heard over third or fourth interspace, modified by pressure with the stethoscope, by respiration, and by patient's position. A friction fremitus may be felt.

When *effusion* occurs, the symptoms depend on the primary disease and the nature of the effusion. There is usually delirium, sometimes hemiplegia, and convulsions (associated endocarditis with embolism). In purulent pericarditis recurring chills and intermittent fever; dyspnea depending on amount of infusion; dysphagia and aphonia; cough; rapid and irregular heart action. The *physical signs* are: Bulging of precordia and prominence of interspaces. Apex-beat faint and displaced upward and to left. The friction sound disappears. The cardiac dulness is increased, especially upward and to the left, and triangular, with base upward. Dulness is absolute in the cardiohepatic triangle at the fifth right interspace (Rotch). Heart-sounds are feeble and distant. The pulmonary resonance is modified by the pressure of the fluid. *Pulsus paradoxus* may be present.

Diagnosticate acute fibrinous pericarditis.

Presence of a cause—rheumatism, erysipelas, eruptive fevers, etc. Fever; acceleration or irregularity of pulse; pain over precordia, not influenced by pressure. Symptoms are frequently wanting. Friction fremitus may be felt; a to-and-fro friction sound is usually heard in third or fourth interspace on left side.

Differentiate acute pericarditis from acute endocarditis.

The only valvular lesion that is capable of closely simulating pericarditis is aortic insufficiency with double murmur. The constant character and direction of transmission of the aortic murmur and the arterial phenomena suffice to prevent the error.

Describe the treatment of acute pericarditis.

Treatment of the primary disease: ice-bag or cold coil over precordia to steady the heart action. Cupping or leeches may give relief at the beginning. When *effusion* is present, blisters to the precordia. A purge every other day if the patient's strength permits; iodid of potassium; light, dry diet. Large effusions may necessitate paracentesis.

Make a differential diagnosis of pleuritic and pericardial effusion.

The mistake can occur only in the rare cases of very large pericardial effusion. In left-sided *pleural effusions* the heart is displaced to the right and the dulness extends to the bottom of the pleural sac; in *pericardial effusion* the signs of pleural effusion may be present posteriorly and laterally, but the dulness does not extend below the eighth rib in the axilla; it is increased to the right beyond the sternum, and the heart is not displaced to the right. Certain symptoms, as delirium, cerebral symptoms (from embolism due to associated endocarditis), arrhythmia, aphonia, dysphagia, and *pulsus paradoxus*, which belong to pericarditis, may also assist in the diagnosis.

What are the causes of endocarditis?

Rheumatism, tonsillitis, chorea, scarlet fever, diphtheria, measles (rarely), pneumonia, typhoid fever, septic processes, gonorrhea. *Chronic* endocard-

itis is usually secondary to the acute, especially the rheumatic, form. Other causes are: nephritis, alcohol, the poison of gout and syphilis, and heavy and prolonged muscular exertion (aortic valves).

Give the morbid anatomy of acute endocarditis.

Minute vegetations, from 1 to 4 mm. in diameter, are found on the endocardium lining the ventricles and valves. The lesions consist of leukocytes and blood-platelets capped with fibrin. Later they are converted into connective tissue by the process known as 'organization,' which consists in proliferation of the endothelial and subendothelial cells, and the gradual disintegration and removal of the blood-cells and fibrin. Micro-organisms are usually present, being caught in the meshes of fibrin, or deposited on the apex of the vegetation.

How should endocarditis be treated?

Rest in bed; heart tonics, especially strychnin; digitalis when definitely indicated by threatening failure of compensation; general tonics, iron, and quinin. In chronic cases, if suitable, resistance exercises, mineral baths (carbonated), and graded hill climbing (Schott system).

Give the physical signs of the most usual valvular lesion of the heart.

The physical signs of *mitral regurgitation* are:

Inspection: Displacement of apex-beat to the left and, rarely, downward.

Palpation: Thrill is rare; systolic when present; pulse small and soft; after failure of compensation, irregular and unequal.

Percussion: Cardiac dulness increased transversely.

Auscultation: Systolic murmur heard best at the apex and transmitted to the axilla and the angle of the scapula. Variable in character, sometimes musical. Accentuation of second pulmonic sound.

Why is dyspnea caused by disorganization of the mitral valves?

Because incompetence of the mitral valve leads to dilatation of the left auricle and engorgement of the lungs, followed by dilatation of the right heart, which still further increases the pulmonary congestion.

What are the physical signs of stenosis of the mitral valve?

Inspection: Bulging of the precordia in children. Engorgement of veins in the neck and thorax. Apex-beat not displaced.

Palpation: Presystolic thrill in fourth or fifth interspace inside of nipple line. Systolic shock. Cardiac impulse felt at lower edge of sternum. The characteristic pulse is small and irregular in force and rhythm.

Percussion: Cardiac dulness increased slightly in transverse diameter and upward.

Auscultation: Rough, presystolic murmur inside the position of the apex-beat; not transmitted. Second pulmonic accentuated or reduplicated.

What are the physical signs of aortic regurgitation?

Inspection: Apex-beat displaced downward and to left; area of impulse increased. Pulsation of carotids, temporals, brachials, radials, and aorta (at suprasternal notch and in epigastrium). Capillary pulse.

Palpation: Confirms inspection; diastolic thrill may be felt over sternum. Corrigan pulse.

Percussion: Reveals great enlargement of cardiac dulness (*cor bovinum*).

Auscultation: Diastolic murmur at aortic area transmitted down the sternum. Absence of second aortic sound. Flint murmur may be present.

Pulsation of retinal arteries. Double murmurs heard over arteries.

Where is the aortic regurgitant murmur most distinctly heard?

At aortic area, second right costal cartilage.

Differentiate aortic and mitral valvular diseases.

Aortic disease is characterized by hypertrophy of the left ventricle, recognized by downward and outward displacement of apex-beat. The pulse is characteristic: *Corrigan pulse* in regurgitation, and slow (*pulsus tardus*) in obstruction. Aortic murmurs are heard best at the second right costal cartilage and transmitted into the neck (obstruction) or down the sternum (regurgitation). In *mitral regurgitation* the murmur is systolic and transmitted to axilla and angle of scapula; the presystolic murmur of mitral stenosis is not transmitted and is accompanied by a thrill. The second pulmonic is accentuated and the pulse is not characteristic, except that it is more frequently irregular than in aortic lesions.

Differentiate aortic stenosis and aortic insufficiency.

Aortic Regurgitation.	*Aortic Stenosis.*
Marked hypertrophy of left ventricle (cor bovinum).	Hypertrophy of left ventricle moderate.
Pulse characteristic 'water-hammer,' quick, full, and receding.	Pulse slow and full, rises slowly (pulsus tardus).
No thrill.	Systolic thrill over aortic cartilage.
Diastolic murmur at aortic cartilage or fourth right interspace, transmitted down the sternum.	Systolic murmur at aortic cartilage transmitted into vessels of neck.
Flint murmur sometimes present.	Absent.
Capillary pulse.	Absent.

Give the symptoms and treatment of chronic myocarditis.

Symptoms.—Dyspnea and precordial pain, especially on exertion; cough; gastric and intestinal disturbances due to congestion; and, in advanced stages, edema. The apex-beat is feeble and diffuse; the pulse is weak and irregular in rhythm and force; it may be accelerated or slow.

Treatment.—Rest and careful regulation of diet. Tonics, such as iron, quinin, strychnin, and arsenic, are indicated. Nitroglycerin, beginning with $\frac{1}{100}$ gr. three times a day, and increasing the dose to point of tolerance, relieves the distress when the tension is high. Sedatives may be required to relieve insomnia and restlessness. Digitalis usually does no good.

Make a diagnosis of aneurysm of the descending aorta.

The symptoms and signs peculiar to aneurysm of the descending aorta are: pain between the shoulders; a dull, expansile, pulsating tumor in the left interscapular region, with sometimes erosion of the third to the sixth vertebra. Pressure symptoms: dysphagia, bronchiectasis from pressure on the left bronchus, and sometimes paraplegia from pressure on the spinal cord.

Differentiate embolism and thrombosis.

Embolism.	*Thrombosis.*
Onset sudden, without premonitory symptoms.	Onset gradual and preceded by headache, vertigo, tingling of the fingers and alteration of speech, loss of memory, etc.
Usually sudden and complete loss of consciousness, with disturbance of pulse and respiration.	Loss of consciousness much less common.
Hemiplegia often accompanied by aphasia (left side of brain involved).	Hemiplegia incomplete or variable; develops slowly.
Heart disease often present.	Syphilis a frequent cause.

Give the symptomatology of arteriosclerosis. State predisposing causes.

The general *symptoms* of arteriosclerosis are increased arterial tension, thickening and hardening of the arteries, and hypertrophy of the left ventricle, indicated by a clear, ringing, accentuated second aortic sound. Vertigo and headache are often present. The urine shows the signs of interstitial nephritis.

The *predisposing causes* are old age; chronic intoxications: alcohol, lead, gout, syphilis; overexertion and overeating; Bright's disease.

(a) Define angina pectoris. (b) What pathologic conditions may cause it?

(a) A symptomatic affection, usually associated with sclerosis of the coronary arteries and myocarditis, and characterized by paroxysms of severe pain in the region of the heart, extending into the arms and neck.

(b) Arteriosclerosis, degeneration of the myocardium, aortic insufficiency, and adherent pericardium.

What is the treatment of angina pectoris?

During the attack an amyl nitrite 'perle' should be broken in the handkerchief and inhaled; if this does not give relief at once, chloroform, and finally, if required, a morphin injection; during the intervals, avoidance of excitement and muscular exertion. The two drugs most generally recommended are nitroglycerin and sodium or potassium iodid.

State the varieties, causes, and prognosis of angina pectoris.

1. *True Angina Pectoris.*—Causes: arteriosclerosis, heart disease (aortic insufficiency and adherent pericardium), gout, diabetes, syphilis. Prognosis grave; attack often proves fatal.

2. *Toxic Angina.*—Causes: abuse of tobacco, tea, and coffee. Prognosis guardedly favorable if cause is removed.

3. *Hysteric* or *false angina*, associated with hysteria and neurasthenia. Prognosis absolutely favorable.

4. *Vasomotor Angina* (Nothnagel).—Prognosis as to life favorable.

THE INFECTIOUS DISEASES

Name five diseases caused by a known germ.

Tuberculosis, typhoid fever, Asiatic cholera, diphtheria, and relapsing fever.

What is Asiatic cholera?

A specific disease, due to the *comma bacillus* of Koch, prevailing endemically in some parts of the world, and occasionally becoming epidemic; characterized by vomiting, purging, muscular cramps, and rapid collapse.

Differentiate Asiatic cholera from cholera morbus.

This often presents great difficulties, especially in times of an epidemic of cholera. Rice-water discharges are more common in true cholera. In cholera morbus there is usually the history of an indiscretion in diet. A positive diagnosis can be made only by means of bacteriologic cultures.

Outline appropriate treatment for Asiatic cholera.

Isolation, absolute cleanliness, disinfection of stools and soiled clothing. *Diet:* broths, milk with carbonated water, thin gruels, and alcohol in some form.

Medicinal: Violent vomiting and purging, pain, and cramps require morphin injections for their relief. Vomiting may be controlled with cocain, carbolic acid, creasote, or dilute hydrocyanic acid, a mustard plaster to the epigastrium, or lavage with hot water. If the cramps are not relieved by local hot applications, chloroform should be administered by inhalation. Free enteroclysis with hot water or astringent solutions (1 per cent. tannic acid with laudanum) may assist in controlling diarrhea. In the stage of collapse the patient should be freely stimulated with alcohol and ammonia, and wrapped in hot blankets or placed in a hot bath. Hypodermoclysis not only stimulates the heart, but also combats the concentration of the blood.

Name the places where yellow fever is endemic.

Vera Cruz and other points on the Gulf coast of Mexico and South America; Rio de Janeiro, Brazil; and the west coast of Africa. Havana ceased to be an endemic focus in 1901.

Describe the symptoms of yellow fever.

Incubation usually two or three days (twenty-four hours to eight days). The disease begins suddenly in the early hours of the morning with chill, headache, pain in the back and limbs, and sometimes nausea and vomiting. The temperature rises rapidly to 102° or 103° F. (sometimes as high as

106° F.); the pulse is 100 to 110 and becomes progressively slower; the face is flushed and turgid; the urine contains albumin. On the second day a remission of one or two degrees usually takes place (*stage of remission*), after which the disease may run a favorable course, ending in recovery, or may pass into the complicated or *secondary fever stage.* Jaundice now develops; the fever returns to its original height, with relatively slow pulse; the appearance of the face is characteristic; the vomiting persists, and hemorrhages occur from mucous membranes ('*black vomit*'). Although delirium occurs, there is a peculiar mental alertness; the patient watches everything going on about him. Recovery is rapid in favorable cases; death is due to exhaustion or uremia.

Give the treatment of yellow fever.

Absolute rest in the horizontal position and strict diet from the beginning; plenty of fresh air and daily sponging. There is no specific. A mild laxative should be administered at the onset. Vomiting may yield to broken doses of Seidlitz powders, to calomel, or to cocain; if not, daily rectal injections of hot salt solution and rectal feeding must be tried. As soon as blood appears in the vomit, tincture of the chlorid of iron, 5 drops every two hours, is given. Alcohol, strychnin, and digitalis according to indications. Alcohol and strychnin are not so well borne in yellow fever as in other infectious diseases. During convalescence a tonic mixture of hydrochloric acid and nux vomica should be given. Styptics, as gallic acid, Monsel's solution, and ergot, may be tried to control hemorrhage (black vomit), but are usually of no avail.

How does the cause of typhoid fever principally gain entrance to the human body? Outline the prophylaxis.

Through the alimentary tract.

The prophylaxis consists in securing a good water-supply not contaminated by sewage; the avoidance of uncooked food that has been exposed to infection (oysters, raw vegetables, fruit); and the disinfection or destruction of the patient's excreta, soiled linen, etc. If pure water and milk cannot be obtained, these articles must be sterilized by boiling.

What are the ordinary age limits of typhoid fever, and what conditions are essential to its production?

The age at which enteric fever most frequently occurs is from fifteen to thirty. The disease is caused by the ingestion of water or food infected with Eberth's *Bacillus typhosus*, due to contamination of the water-supply with sewage.

On what symptoms would you base a diagnosis of typhoid fever?

Prodromal symptoms: headache, pain in the limbs, epistaxis. The characteristic temperature-curve, showing a gradual rise with daily remissions; splenic enlargement; pea-soup stools; dicrotism of the pulse; rose spots and the Widal reaction in the second week.

Describe the eruption of typhoid fever.

Discrete, slightly raised, hyperemic macules, so-called rose spots or roseolæ, varying in size from a pin-head to a pea, and disappearing on pressure. The spots appear about the beginning of the first week, chiefly upon the abdomen, also the lower chest, back, and thighs. They recur in crops throughout the second and during the third or fourth week.

Differentiate typhoid fever and remittent fever.

The clinical course and the temperature-curve may be quite similar in the two diseases, and a positive diagnosis can be made only by the presence of the Widal reaction in typhoid fever, and by finding the *Plasmodium malariæ* in the blood in malaria. Splenic enlargement is present in both. Herpes labialis points to malaria. In typhoid fever prodromata usually occur, and the initial symptoms are usually more severe. As the disease progresses the characteristic dicrotism of the pulse develops.

Give the differential diagnosis between cerebrospinal meningitis and typhoid fever.

Cerebrospinal fever sets in suddenly with chill and vomiting; stiffness of the neck muscles is an early and well-marked symptom; headache is severe and persistent; delirium is often present from the beginning; photophobia is present, and there is sensitiveness to noise. The temperature is irregular and the curve is not characteristic; the pulse is usually full and strong, and may be remarkably slow; herpes is common.

In *typhoid fever* the onset is gradual and preceded by prodromes; the temperature is continuous, with daily remissions; the pulse is dicrotic; the headache subsides; splenic enlargement and the Widal reaction are present; nervous symptoms are marked until late in the course of the disease.

Leukocytosis is present in cerebrospinal meningitis and absent in typhoid. Lumbar puncture and the finding of *Diplococcus intracellularis* in the cerebrospinal fluid establishes the diagnosis of cerebrospinal meningitis.

When is perforation in typhoid fever most likely to occur?

Toward the end of the second, and during the third, week.

Describe the symptoms indicative of intestinal perforation in typhoid fever and its treatment.

Sudden acute pain in abdomen, followed by marked tenderness, rigidity, vomiting, and collapse. The pulse is small and rapid. Other symptoms are often very ill defined and sometimes absent. A sudden fall in temperature may occur. Leukocytosis is often a valuable symptom, as the leukocytes are low in uncomplicated typhoid fever. Obliteration of the liver dulness in front is sometimes noted. The treatment is surgical.

Name one important complication and one important sequel of typhoid fever.

1. Perforative peritonitis. 2. Deafness due to middle-ear disease.

State your treatment, including diet, of typhoid fever.

Begin the treatment with a calomel purge. The temperature, pulse, and respiration are taken every three hours, except when the patient is asleep; if the temperature exceeds 102.3° F. in the mouth, the patient is tubbed by the Brand method or sponged. Enema of soapsuds or saline solution every other day, if the bowels do not move. Diarrhea persisting after the first week should lead to careful bacteriologic examination of the milk supply, and must be checked by dietetic and medicinal means. (Stop the milk and administer bismuth.) No drugs are needed except for the relief of symptoms; but salol, urotropin, or some other intestinal disinfectant, and dilute hydrochloric acid may be given throughout the disease. After the third week and during convalescence strychnin, alcohol, and iron are indicated. The *diet* must be liquid throughout the febrile period; milk is to be preferred to all other foods, but broths and thin soups may be substituted. After the temperature has remained normal for ten days, semisolid food is added to the diet and the patient is gradually allowed to return to ordinary food.

Describe the Brand method of treatment in typhoid fever.

The bath-tub is brought to the side of the bed and the patient is lifted into it by two attendants so that the entire body is submerged, the head being supported on a rubber pad. Cold water is poured over the head and face during the immersion, or an ice-cap applied to the head, and the entire body, with the exception of the abdomen, *briskly rubbed* by the attendants during the entire duration of the bath. Brand begins with water at *68° F.*, and reduces the temperature at subsequent tubbings as low as 59° F. The *duration* is from ten to twenty minutes, according to the patient's reactive power, and the bath is repeated *every three hours*, day and night, regardless of sleep, so long as the rectal temperature exceeds 102.2° F. Before and after the bath the patient receives a glass of red wine (in America, whisky or aromatic spirits of ammonia is usually given). The patient is lifted out of the tub at the end of the bath and wrapped in blankets for half an hour, when the temperature is again taken to note the effect of the bath.

What is the treatment of diarrhea occurring in typhoid fever?

Disinfection of the milk usually suffices to check the diarrhea after the first few days. Bismuth in large doses is the most reliable drug; opium may be called for.

Give the treatment of intestinal hemorrhage in typhoid fever.

Ice-bag to the right iliac fossa and morphin ($\frac{1}{4}$ gr.) hypodermically at once; or opium ($\frac{1}{2}$ gr.) by the mouth, repeated until a decided effect is produced. Monsel's solution and ergot are sometimes recommended. Feeding may be continued by the mouth in most cases.

Describe a typical case of typhus fever.

There is early prostration with headache, pain in the back and legs, vomiting, and epigastric pain. The face is flushed, the expression dull,

and the eyes are congested. The tongue is furred and white and soon becomes dry. The *fever* attains its maximum on the second or third day; the pulse is full, rapid, and not dicrotic. Severe *nervous symptoms* appear early and convulsions are common. There is moderate enlargement of the liver and spleen. The papular, rose-spot *eruption*, with petechiæ, appears about the fourth or fifth day, covering the entire body. At first the skin is mottled. In favorable cases the fever ends by crisis about the fourteenth day, but death may take place as early as the third day.

Describe the eruption of typhus fever.

It appears between the third and fifth day,—first on the abdomen and chest,—spreading within two days to the face and limbs. At first it consists of a fine, irregular, dusky mottling; this is followed by distinct, papular *rose-spots* closely resembling measles and changing later to *petechiæ*. The rash is hemorrhagic and does not disappear after death.

Outline a plan of treatment of typhus fever.

There is no specific. Free ventilation is essential; the open-air treatment is strongly recommended. Hyperpyrexia must be controlled with hydrotherapeutic measures, bathing, wet packs, or sponging; an ice-bag should be applied to the precordia. Antipyretic drugs, phenacetin, lactophenin, and the like are recommended by some. The diet should be the same as in typhoid fever. Strychnin, alcohol, and heart stimulants are usually required, and the bromids or opium to allay insomnia and delirium.

What causes cerebrospinal meningitis, and how should it be treated?

The exciting cause is the *Diplococcus intracellularis meningitidis*, described by Weichselbaum in 1887.

The treatment is purely symptomatic. Cold applications to the head and to the spinal cord are useful. A laxative dose of calomel early in the course of the disease, and mercury throughout the entire affection, has many advocates. Opium, perhaps, offers the best mode of treatment, and there is a remarkable tolerance for this drug even in the very young. If vomiting is a prominent symptom, morphin should be given hypodermically. Chloral, the bromids, and cannabis indica have been used, but in effect cannot be compared with the systematic use of opium. Alcohol is necessary when depression shows itself and asthenia is marked. Strychnin should not be given. The diet should be as liberal as the digestive powers permit.

What are the clinical features of cerebrospinal meningitis?

Sudden onset with chill and vomiting; variable degree of *fever*—usually moderate, 101° to 103° F., but sometimes as high as 105° or 106° F.; intense *headache with photophobia* and general hyperesthesia; stiffness and pain in the muscles of the back and neck; tremors and clonic and tonic *convulsions;* delirium, followed by stupor and coma; herpes, petechiæ, and other eruptions; *Kernig's sign; leukocytosis.*

Describe the symptoms of tuberculous meningitis.

The *onset is insidious*, and preceded by prodromal symptoms—peevishness, loss of appetite, fitful and broken sleep, headache, grinding of the teeth. The first stage, or *stage of irritation*, may be ushered in by a convulsion or the tripod of headache, vomiting, and fever. *Headache* is intense; the child puts its hand to its head and from time to time gives a sudden cry—the so-called hydrocephalic cry. *Vomiting* occurs without apparent cause and independently of taking food. *Fever* is moderate—102° to 103° F. Pulse at first rapid, and later irregular and slow. The pupils are contracted. The bowels are obstinately constipated. The child is excited. During the *second stage* the irritative symptoms subside and the child becomes dull and apathetic. Vomiting ceases; the abdomen is retracted or scaphoid, the head is thrown back, and muscular rigidity and convulsions occur. The pupils are dilated or irregular and strabismus may develop. The *temperature* is variable, but not usually much elevated. The final stage, or *stage of paralysis*, is marked by increasing coma, convulsions, and spasms in various parts of the body. The pupils are dilated and the eyes only partially closed; the ocular muscles may be paralyzed. The pulse becomes rapid and feeble, and the patient sinks into the *typhoid state*. Sometimes an agonal rise of temperature takes place. A moderate leukocytosis (10,000 to 15,000) may be present throughout the course of the disease. The entire duration is from ten days to three weeks.

Differentiate in a general way between cerebrospinal fever and tuberculous meningitis.

Cerebrospinal Fever.	*Tuberculous Meningitis.*
Abrupt onset with chill and vomiting.	Onset gradual.
Excruciating pain in head, back, and limbs; opisthotonos.	Pains less severe; opisthotonos rare.
Herpes facialis and other skin eruptions: purpuric, blotchy rash, roseola, erythema, urticaria, etc., sometimes petechiæ.	Herpes facialis and other eruptions rare. Petechiæ always absent.
Leukocytosis.	Not present; leukopenia.
Cerebrospinal fluid contains *Diplococcus intracellularis meningitidis*.	Sterile or contains tubercle bacilli.

Give the symptoms of acute spinal meningitis.

The disease usually begins with chill and a temperature of the aseptic type. There is severe pain in the back, increased by motion, and radiating into the extremities. Hyperesthesia is general. The muscles of the back are rigid and very tender on pressure; opisthotonos may be present. Pressure of the exudate on the cord may cause anesthesia and partial paralysis of extremity; the sphincters may be paralyzed. Cerebral symptoms are absent.

THE ACUTE ERUPTIVE FEVERS

What is understood by an exanthematous fever?

A fever in which a characteristic eruption occurs.

Mention the eruptive fevers.

Scarlet fever, measles, German measles or rubella, variola, and varicella.

Give the period of incubation and of eruption of the exanthemata.

	Incubation.	*Eruption.*
Scarlet fever:	A few hours to a week.	End of first or beginning of second day.
Measles:	About two weeks.	On the fourth day.
Rubella:	About two weeks.	On the first or second day.
Variola:	From seven to twenty-one days.	On the third or fourth day.
Varicella:	One to two weeks.	On first day.

Describe the skin appearance in (a) rubeola, (b) rubella, (c) scarlatina, and (d) varicella.

(a) *Rubeola.*—Maculopapules; the lesions are small, dark red, and arranged in groups with crescentic borders. Eruption begins on the face about the fourth day and rapidly spreads over the entire body. It fades gradually and is followed by branny desquamation.

(b) *Rubella.*—Multiform; sometimes consisting of pale red, slightly elevated, discrete papules (rubella morbilliformis); sometimes resembling erythema (rubella scarlatiniformis) or urticaria. The eruption appears on the first day, fades rapidly, and is sometimes followed by fine desquamation.

(c) *Scarlatina.*—Eruption scarlet red, punctiform, and diffuse, appearing at the end of the first, or beginning of the second day on the neck and chest, and rapidly spreading over the entire body. It disappears on pressure. It fades gradually in five or six days, and is followed by scaly desquamation, an entire cast of a hand or foot rarely coming away at one time.

(d) *Varicella.*—Eruption vesicular, appearing on first day. Superficial, transparent vesicles; unilocular, rarely umbilicated, not surrounded by inflammatory areola; appear in crops over two or three days and lasting about a week. Distribution: face, neck, and parts of trunk.

Describe the diagnostic characteristics of the eruption of typhoid fever, small-pox, and chicken-pox.

The eruption of *typhoid fever* appears about the *seventh day*, consisting of slightly elevated, *rose-colored spots*, which disappear on pressure and appear again after the pressure is removed; they occur in crops, having a duration of from two to three days; they appear commonly on the abdomen, chest, between the shoulder-blades, extremely rarely upon the face. The eruption of *small-pox* appears on the *third day* in the form of macules passing through the successive stages of *vesicle*, *pustule*, crust, and scar. During the papular stage the lesions feel like shot under the skin. The pustule is *umbilicated* and has an inflammatory areola; the eruption appears all over the body, especially on the exposed parts—the face and extensor surface of the forearms and hands. The eruption of *chicken-pox* appears on the *first day* as a small reddish papule, which in a few hours becomes a *vesicle;* the latter is thin and transparent, *unilocular*, not umbilicated, and not surrounded by an inflammatory areola.

Differentiate the early eruption of syphilis and measles.

Syphilis.	*Measles.*
History of chancre six weeks previous to eruption.	History of acute onset with fever and catarrhal symptoms three days before eruption appears.
Fever usually absent; presence of mucous patches in oral cavity.	Symptoms of coryza, conjunctivitis, and usually bronchitis with cough.
Eruption copper-colored and not especially prominent on face.	Eruption appears first on face and rapidly spreads to entire body.

Differentiate variola and varicella.

In *variola* the eruption appears on the third day, preceded by fever, backache, and other marked constitutional symptoms. The eruption goes through the successive stages of macule, papule, vesicle, and pustule, which is umbilicated and surrounded by an inflammatory areola. *Varicella* is essentially a disease of childhood. The eruption appears on the first day and is vesicular almost from the beginning. There is rarely much fever or constitutional disturbance.

What is the period of incubation in variola and vaccinia?

Variola, seven to twenty-one days; vaccinia, from two to seven.

Give the symptoms of an ordinary case of scarlet fever.

The disease begins *suddenly*, with chill or a convulsion. There are nausea and vomiting, *high temperature*, *very rapid pulse*, and marked angina. There is enlargement of the lymphatics at the angle of the jaw. At the end of the first or beginning of the second day an *eruption* appears all over the body, which has the color of a boiled lobster. The eruption lasts four to five days and disappears by desquamation. *Nephritis* is a frequent complication.

What is the period of desquamation in scarlet fever?

The period of desquamation in scarlet fever usually begins after the appearance of the eruption, or when the eruption has been prominent for about four or five days. It may last from several days to several weeks or more. The desquamation is usually in large scales.

How should scarlatina be treated?

Strict isolation until desquamation has ceased. Light, nutritious diet, consisting chiefly of milk; the bowels should be kept open by mild laxatives given at short intervals. Sponging with tepid water twice a day as long as the fever is 103° F. and over. The entire body should be anointed daily with petrolatum. After the fever has subsided a diuretic mixture of potassium citrate and liquor ammonii acetatis with tincture of the chlorid of iron, five to ten drops four times a day, according to age. The throat must be kept clean by spraying with an alkaline antiseptic solution, such as Dobell's solution, or with dioxid of hydrogen, 1 part to 3 parts of water, or saturated boric-acid solution. If the heart-sound is weakened, strychnin and digitalis may be necessary. The urine should be examined daily.

How should acute nephritis accompanying or following scarlet fever be treated?

Absolute milk diet and absolute rest in bed. An alkaline mineral water, such as Seltzer or Vichy, may be mixed with the milk. Daily sponging with tepid water. Calomel in fractional doses, followed by saline, should be administered two or three times a week, and a diuretic mixture combining potassium citrate and sodium benzoate should be given continuously. Basham's mixture is a useful iron preparation. If the condition permits, a daily hot-air bath may be given to induce sweating.

What are the complications and sequelæ of scarlet fever?

Nephritis, endocarditis and pericarditis, suppurative otitis media, enlargement and suppuration of lymphatic, and sometimes submaxillary glands, arthritis ('rheumatism'), diphtheria. Among the rarer complications are monoplegia, hemiplegia, peripheral neuritis, meningitis, and peritonitis.

Give the etiology of scarlet fever.

Age is an important predisposing cause. It rarely occurs after the tenth year of life. Neither sex nor occupation predispose to it. The disease is more common in cold and temperate regions. Epidemics are more prevalent in the winter. In this disease there is a marked personal predisposition. One attack confers immunity, as a rule. The exciting cause is not known.

How are the lymphatic glands involved in scarlatina?

The lymphatic glands at the angle of the jaw and of the neck are usually enlarged, sometimes greatly, so that they form what is known as the 'collar of brawn.'

On what day does the rash usually appear in scarlatina?

At the end of the first, or beginning of the second, day.

Define rubeola and describe its symptoms.

Rubeola, or measles, is an acute infectious disease, characterized by an initial coryza and a rapidly spreading eruption.

Symptoms.—The period of *incubation* is about two weeks. The initial symptoms are coryza, watering of the eyes and photophobia, chilliness, and cough. The temperature is high, rising *gradually* during the second and third days to 103° or 104° F. On the fourth day, when the fever is at its height, the rash appears upon the face and rapidly spreads to the body. There are bronchitis and sore throat, and the cervical glands are enlarged. Râles are heard in the chest. The fever falls by crisis about the sixth or seventh day. The *eruption* is maculopapular; the small red or brownish papules can be felt with the finger and are arranged in groups with crescentic outlines, showing healthy intervening skin. The rash begins to fade in two or three days and is followed by branny desquamation.

Koplik's sign, consisting of small bluish-white specks surrounded by a red areola on the mucous membrane of the lips and cheeks, and preceding the cutaneous eruption, is present.

Describe the treatment of measles.

The child should be kept in a dark room, away from noise. Calomel in fractional doses at the beginning of the disease. There are no specifics. A fever mixture containing sweet spirits of niter and ammonium acetate may be given, and the patient should be guarded against catching cold in order to avoid the most serious complication—bronchopneumonia. The diet must be light and nourishing.

On what day of the disease does the rash usually appear in measles?

On the fourth day.

Differentiate scarlatina, measles, and roseola.

Scarlet fever sets in abruptly with chill, vomiting, convulsion, high temperature from the beginning, and very rapid pulse (140 to 160); sore throat and swelling of submaxillary glands are usually present. *Measles* is preceded by prodromal symptoms; the fever is not so high nor the pulse so rapid, and there is a remission on the second day; concomitant symptoms are cough, coryza, lacrimation, and photophobia; Koplik's spots are seen on the buccal mucous membrane. In *roseola* the constitutional phenomena are slight, the temperature is moderate, and there are slight sore throat and mild gastric disturbance.

How should small-pox be treated?

As soon as the diagnosis is made, the patient should be vaccinated. Strict *quarantine* must be observed. In most communities the patient must be sent to the public hospital for contagious diseases. The room should be darkened; exclusion of the sunlight is said to prevent pitting. At first the *diet* should be liquid, as in other febrile diseases; laxatives are given as required. As there is no specific, the medicinal treatment is purely symptomatic and supportive. Warm baths are recommended. Vomiting and diarrhea, which are frequently troublesome, must receive suitable treatment (small doses of calomel, bismuth). The pain may be severe enough to require morphin. During the period of secondary fever the patient must be stimulated freely with strychnin and alcohol; abscesses must be incised and covered with an antiseptic dressing.

What are the general or constitutional symptoms of diphtheria?

Moderate fever, chilliness, malaise, sore throat, aching pains in the back and limbs, and rapid and feeble pulse. The prostration is out of proportion to the fever. Young children may have convulsions.

Differentiate diphtheria from follicular tonsillitis.

The *diphtheritic membrane* is sharply defined and surrounded by an inflamed areola. It covers all parts of the pharynx, uvula, and tonsils, is removed with difficulty, leaves a bleeding surface, and quickly reforms. The presence of the Klebs-Löffler bacillus establishes the diagnosis of diphtheria. The exudate of *follicular tonsillitis* is confined to the crypts of the tonsils and is easily removed.

Give in detail the treatment of diphtheria.

Strict *isolation* until the throat is free from Klebs-Löffler bacilli. Thorough disinfection of bedding, clothing, and all utensils used by the patient. Absolute rest and liquid diet.

Administer *antitoxin* as soon as diphtheria is suspected, without waiting for bacteriologic confirmation of diagnosis. Pure antitoxin is harmless and must be given in large doses to effect a cure. The smallest *curative*

dose is 3000 units (according to some authorities, 5000), which should be repeated, if necessary, every four to six hours until distinct improvement is noted. Those who have been exposed to contagion should receive an *immunizing* dose of from 500 to 1000 units, according to age. The injection is made under strict antiseptic precautions between the shoulder-blades or in the buttocks.

The heart must be carefully watched, and digitalis, strychnin, alcohol, or other heart stimulants administered on the first evidence of cardiac weakness. The *special remedies* recommended are tincture of the chlorid of iron, 4 mm. every two hours to a child of three or four, and bichlorid of mercury, from $\frac{1}{40}$ to $\frac{1}{20}$ gr. for the same age. Water medicated with turpentine or oil of eucalyptus should be evaporated in the room, and the nasopharynx sprayed with Dobell's solution, dilute hydrogen dioxid, or bichlorid of mercury (1:2000). If the glands in the neck are swollen and tender, *ichthyol*, belladonna, or mercury ointment may be applied, without rubbing. In laryngeal diphtheria *intubation* or tracheotomy must be resorted to if asphyxia threatens.

What treatment would you recommend for diphtheritic paralysis? What is the prognosis?

Rest, tonics, strychnin; later, electricity is useful. The prognosis in all forms of diphtheritic paralysis is favorable, as a rule, except in paralysis of the heart.

Give the etiology, duration, and prognosis of pertussis.

It is an infectious disease of early childhood, and common between the second and seventh year. The disease usually lasts from six to eight weeks. The prognosis, as a rule, is favorable, the danger being due to complications.

What is the natural duration of whooping-cough?

From six to eight weeks.

What are the complications and sequelæ of whooping-cough?

Bronchopneumonia is a frequent complication; pleurisy and lobar pneumonia sometimes occur. Petechial hemorrhages involving the face and the conjunctivæ, epistaxis, and hemoptysis; convulsions; hemiplegia and monoplegia rarely occur. Sudden death may result from a subdural hemorrhage. Pulmonary tuberculosis not infrequently develops after whooping-cough.

Give the treatment of whooping-cough.

It is important that the *diet* be abundant and nutritious, and if the child vomits, it should be encouraged to eat again immediately. There is no specific, and many remedies have been recommended, such as antipyrin, bromoform, belladonna, asafetida, and the like. Caution is necessary in administering coal-tar products. Hygienic and dietetic treatment are the most important. Quinin and other tonics may be given. Menthol, dilute hydrogen dioxid, eucalyptol, or the compound tincture of benzoin may be given by inhalation. The child should be kept in the open air constantly.

Define epidemic parotitis. What complications may arise in the course of this disease?

An acute contagious disease characterized by moderate constitutional symptoms and swelling and inflammation of the parotid and other salivary glands. The complications that may arise are swelling of the testicles, ovaries, and mammary glands.

At what age is spasmodic croup most common? Give the symptoms and treatment of spasmodic croup.

In early childhood.

Symptoms.—The child is awakened from sleep by a severe paroxysm of cough of a peculiar, hard, metallic quality; the face is anxious, the nostrils dilated, and there is extreme inspiratory dyspnea. After an interval of a few seconds to an hour the cough ceases, the child breaks into a perspiration, and falls asleep.

Treatment.—A hot bath or a sponge saturated with hot water applied to the throat. If this fails, an emetic (ipecac) usually brings relief. Between the attacks tonics should be administered, and the laryngeal catarrh, if there is any, should be treated.

Give the symptoms and signs of acute articular rheumatism.

The attack may be preceded by tonsillitis, or merely by general malaise; or the *onset* may be sudden, with moderate fever and sometimes a chill. The signs of inflammation, pain, heat, swelling, and redness develop in one or more of the large joints; the *temperature* varies between 102° and 104° F.; the pulse is rapid and soft. The *urine* is high-colored, acid, scanty in amount, with a high specific gravity, containing phosphates and urates, and sometimes uric-acid crystals in excess; the chlorids are diminished and rarely there is febrile albuminuria. A *leukocytosis* is present. Skin *eruptions*, such as urticaria, sudamina, a purpuric rash, and erythema are common, and copious *acid sweats* often occur. Several of the larger joints are involved *in succession;* as the symptoms subside in one joint they develop with more intensity in another. A heart murmur is usually present at the height of the fever, and may persist after the attack is over, in which case the murmur indicates the development of *endocarditis.* A variable degree of *anemia* is always present.

Describe the treatment of acute inflammatory articular rheumatism.

Absolute rest in bed and light *fever diet:* milk with some alkaline mineral water, broths, soups, eggs, and light farinaceous foods; no meats until convalescence has been established. The patient must drink plenty of *water*, mineral water, or lemonade. He should wear a flannel nightgown to guard against sudden changes of temperature. If the fever is excessive, it should be controlled with sponging. Internally, one of the preparations of salicylic acid must be administered in liberal doses, with an intermission of forty-eight hours, at short intervals. *Sodium salicylate* (10 to 15 gr. every three hours), salicin, salicylic acid, or salol (5 to 10 gr. four times a day), may be selected. The oil of wintergreen may be given internally, 20 drops in milk four times a day, or the synthetic methyl salicylate by

inunction. To this may be added an alkaline drink, say potassium bicarbonate, 30 gr. in half a tumblerful of water, three or four times a day. If the urine is hyperacid, sodium bicarbonate in 20-grain doses may be given every two hours until the reaction becomes neutral. Dover's powder may have to be given to relieve pain and discomfort. *Locally*, the affected joints should be wrapped in cotton or gauze saturated with one of the following applications: chloroform liniment, *ichthyol*, lead-water and laudanum, or a saturated solution of magnesium sulfate. Fixation by means of plaster casts has been recommended. After convalescence has been established, the diet should be enlarged and *tonics*, such as iron, quinin, and strychnin, administered.

How may rheumatism affect the respiratory organs?

Pleurisy with or without effusion may occur in the course of rheumatic fever.

What is the usual reaction of the urine in (a) chronic cystitis and (b) acute articular rheumatism?

In chronic cystitis the reaction is usually *alkaline;* in acute articular rheumatism, markedly *acid.*

What cardiac lesions are likely to accompany or to follow acute articular rheumatism, and how may they be recognized by the aid of the stethoscope?

Pericarditis, endocarditis, and myocarditis. The mitral valve is the one most frequently affected. Pericarditis may be recognized by the friction sound; endocarditis gives rise to a regurgitant or stenotic murmur.

What condition of the blood is generally prominent in all forms of rheumatism?

There is marked anemia. The red blood-cells may be reduced one-half or more in number; the hemoglobin may be reduced to 50 per cent.; there is a distinct leukocytosis.

Differentiate neuritis and rheumatism.

In *neuritis* the pain is commonly along the nerve-trunks; trophic changes occur; there may be foot-drop or wrist-drop; fever is slight. There may be a history of alcoholism or diabetes. In *rheumatism* there are redness, swelling, and pain in the joints, acid sweats, frequent implication of the membranes of the heart, and marked deposits of urates in the urine.

Differentiate acute articular rheumatism and periostitis.

Acute rheumatism is characterized by redness, swelling, and pain in the *joints*, by fever of a moderate range, by acid sweats, and a constant tendency to inflammation of the serous membranes of the heart. *Periostitis*, as a rule, follows an injury. The redness and swelling are localized usually in the shaft, the pain is severe, and is not referred to the joints. There are no acid sweats, and pus formation may occur, which is exceedingly rare in acute rheumatism.

What are the manifestations of hereditary syphilis?

From one to twelve weeks after birth the infant develops nasal catarrh,—'snuffles,'—stomatitis, and ulcers at the angles of the mouth, leaving the characteristic fissures. The *eruption*, which appears soon after, is symmetric, like a secondary eruption, and exhibits the same polymorphous character and ham color as the acquired form. The palms of the hands and soles of the feet are often involved. Emaciation and anemia gradually give the child the appearance of a 'wizened, dried-up old man.' Hutchinson's teeth (the upper central incisors are dwarfed and notched), keratitis, and 'saddle-nose' (necrosis of the nasal septum) are late manifestations of hereditary syphilis corresponding to tertiary lesions of the acquired form.

What are the diagnostic points in secondary syphilis?

Languor, pains in the bones (tibia, sternum), nocturnal headache, slight fever, and anemia, a characteristic eruption, ulcers, and mucous patches on buccal mucous membrane and on the tongue; sometimes falling out of hair.

Describe iritis and give its treatment.

Iritis is inflammation of the iris. The membrane loses its luster, the color changes, there is pericorneal injection, the pupil is contracted, the cornea may be hazy, and the aqueous humor becomes turbid, or pus, blood, or exudate may accumulate in the anterior chamber. The *subjective symptoms* are: pain, of a throbbing or stabbing character, in the eyeball and in the brow and temple; impaired vision, photophobia, and lacrimation.

Treatment.—Dry or moist *heat* externally and analgesics (phenacetin, morphin, if required) to relieve the pain; instillation of *atropin* and treatment directed against the causal condition (rheumatism, gout, syphilis). Alteratives are always indicated. Syphilitic iritis calls for mercury, internally or by inunction, and potassium iodid. Sweat-baths and inunctions of bichlorid of mercury are of value in most forms of iritis.

Give the etiology and describe the symptoms of idiopathic erysipelas.

The specific micro-organism is *Streptococcus erysipelatis* of Fehleisen, probably identical with *Streptococcus pyogenes*. In the idiopathic form no portal of entry can be found, although it is probable that the streptococcus effects an entrance through slight abrasions about the nose and lips. Old age, unsanitary conditions, and malnutrition are predisposing factors.

The disease begins with malaise, followed by rigor or chilliness and rapid rise of temperature. Within a few hours a flush appears—usually on the bridge of the nose and the cheeks. The skin becomes smooth, tense, and edematous, and large *blebs* usually develop. The patient complains of heat and tension in the affected part. The eyes are closed, and the eruption may spread to the conjunctivæ. As the *eruption* advances, by a clearly defined margin, in one direction, the part first affected gradually pales and the skin returns to its normal condition. The temperature is high and continuous; *leukocytosis* is present. Constitutional symptoms are well marked, and delirium may be present, especially in the aged. The *duration* in favorable cases varies from one to two weeks.

Give the treatment and prognosis of erysipelas.

Treatment.—Cold water should be liberally administered to the patient, and cold sponging, especially if the temperature is high, is of distinct advantage. Boric acid is the best treatment for the eruption. An ointment of *ichthyol* and lanolin is also used for this purpose. Internally, tincture of the *chlorid of iron* in full doses is given. When the nervous symptoms become prominent, and in the aged or cachectic, bold stimulation is necessary; alcohol is best for this purpose. If the pain is severe, morphin is injected. *Antistreptococcic serum* may be beneficial, and should always be resorted to in malignant cases.

Prognosis.—In simple, uncomplicated cases occurring in those in previous good health the prognosis is favorable. It should be regarded as serious when erysipelas occurs as a complication of any other malady, in the puerperal state, or when it results from surgical accidents. It is always serious in alcoholic and cachectic subjects, and in the aged.

Give the etiology of tetanus.

The disease occurs in either sex and at any age. It is more common in the tropics than in temperate climes. It may result from a wound in any part of the body, and sometimes without apparent trauma. It occurs most often from wounds that are exposed to dirt and filth. The exciting cause is *Bacillus tetani,* described by Kitasato.

Give the symptoms and treatment of tetanus.

Symptoms.—The first symptoms, which make their appearance usually within ten days of the injury, are stiffness of the neck, *tightness of the jaws*, and difficult mastication. Gradually the muscles of the abdomen and extremities are also involved. The spasm is tonic. The face is distorted (*risus sardonicus*); the jaws are tightly closed (*trismus*); the body is arched and supported on the back of the head and the heels (*opisthotonos*). Dyspnea may be present from spasm of the respiratory muscles. The *temperature* is variable and may be normal until just before death, when it becomes excessively high—108° F. and more. The mind is clear to the end; there is intense hyperesthesia to touch and sound.

Treatment.—Potassium bromid in large doses, one dram every two hours, and chloral to control the convulsions; chloroform by inhalation, if asphyxia threatens. Morphin is usually required to relieve pain. Rectal or nasal feeding and free stimulation. Strychnin is *counterindicated.* The wound must be treated antiseptically. *Tetanus antitoxin* appears to have some value and should be tried; statistics indicate that its use has reduced the mortality nearly one-half. It may be administered by subcutaneous or subdural injection, preferably the former, or in the form of a powder dusted on the wound. The dose has not been determined.

Give the etiology and treatment of anthrax.

Anthrax is caused by *Bacillus anthracis*, which is conveyed to animals by the bites and stings of insects or by feeding in pastures infected with the bacilli or their spores. From animals the disease is rarely transmitted to man, and accordingly occurs among stablemen, butchers, sheep-herders, wool-sorters, tanners, and the like.

Give the symptoms of epidemic influenza.

The *onset* is sudden, with fever, headache, and pain in the back and limbs. The *prostration* is out of proportion to the fever, which is usually moderate, and the other constitutional symptoms. The *headache* is severe and obstinate, usually frontal in distribution.

Various types are distinguished: (a) *Respiratory:* The most common form, characterized by coryza and bronchitis. The fever is apt to be high, and the prostration and debility are very great. Pneumonia, pleurisy, and empyema may develop as complications. (b) *Gastro-intestinal:* Onset with nausea and vomiting or abdominal pain and diarrhea. Jaundice may be present and the spleen is often enlarged. (c) *Nervous:* Catarrhal symptoms are not marked; there is severe headache, with pain in the back and joints and great prostration. Meningitis, abscess of the brain, and numerous disturbances of the nervous system may result from this form. (d) *Febrile:* Fever is the most prominent symptom. It may be remittent, with chills, or continued, and simulate typhoid fever.

Give diagnosis, prognosis, and treatment of acute otitis media.

Diagnosis.—Agonizing *pain* in one or both ears, with high fever—103° to 104° F.—and marked constitutional disturbances in children. Adults complain of pain and fulness, with some impairment of hearing, but fever and general disturbance are slight. The drumhead appears red and congested and bulges in its posterior half. There is serous *discharge* from the meatus. Purulent otitis is very apt to follow.

The *prognosis* is favorable in uncomplicated cases and in the absence of pus.

Treatment.—Diaphoresis by means of hot lemonade, Dover's powder, or pilocarpin; if the pain is severe, morphin. Hot douching or local application of heat with hot-water bag or hot bran or hop bag; no poultices. Leeches may be applied in front of the tragus. The pharynx should be kept clean with a saturated solution of boric acid or potassium chlorate.

What complications should be guarded against in inflammatory conditions of the ear?

Extension of the inflammation to the mastoid cells, meninges, or brain, by early incision of the drumhead if an abscess forms in the middle ear.

DISEASES OF THE DIGESTIVE ORGANS

Define simple acute stomatitis. At what age is it most common and what is its treatment?

Diffuse, catarrhal inflammation of the oral mucous membrane; most common in young children.

Treatment.—Good hygiene, cleanliness, and careful feeding, with attention to the gastro-intestinal tract. The child's mouth should be washed every three hours with a mild mouth-wash of boric acid, hydrogen dioxid, or potassium permanganate. As a prophylactic measure the baby's mouth should be wiped out with a mild solution of boric acid before each feeding.

Give the diagnosis and treatment of acute follicular tonsillitis.

The *diagnosis* is based on the presence of pain in the throat, increased by swallowing, with high fever, up to 104° or 105° F. The tonsils are red and swollen, and the crypts filled with yellowish plugs of degenerated epithelium, which can be removed with ease. *Scarlet fever* is differentiated by the history, the strawberry tongue, and the abnormally rapid pulse in proportion to the temperature. In *diphtheria* the false membrane covers the pharynx as well as the tonsils, and its removal is followed by bleeding; the Klebs-Löffler bacillus is found in the throat.

Treatment.—At first sodium salicylate, 15 to 20 gr. three or four times a day, or the ammoniated tincture of guaiac, 2 dr. every two or three hours. Phenacetin and Dover's powder to relieve the pain and secure rest and sleep. Thirst is relieved with small pieces of ice. A cold throat compress is recommended. Locally, the inflamed area may be touched with a strong solution of silver nitrate (½ to 1 dr. to the ounce, or 50 per cent. argyrol), potassium chlorate with tincture of the chlorid of iron, or dusted with bicarbonate of soda.

What are the diagnostic signs of retropharyngeal abscess?

Fever and the general signs of an infection; refusal to take food; rapid emaciation; dyspnea and *dysphagia;* a peculiar cry, likened to the quacking of a duck; stiffness of the neck muscles and enlargement of the glands at the angle of the jaw; inability to close the mouth in severe cases. The posterior pharyngeal wall, usually on one side only, bulges; the soft palate and uvula protrude; *fluctuation* is detected over the swelling.

What is the treatment of spasmodic stricture of the esophagus?

Removal of the cause if it can be found; tonics, such as iron, quinin, and arsenic; systematic passing of a bougie; electricity; moral support.

How should cholera morbus be treated?

Absolute rest in bed and withdrawal of all food for twenty-four hours. one ounce of castor oil (for an adult) should be given at once. Hot-water bag, hot turpentine stupe, or a mustard plaster to the abdomen. Later, a prescription containing bismuth subnitrate, 10 to 15 gr., and creosote or other antiseptic, every two or three hours, should be ordered. After twenty-four hours sterilized milk, soups, and broths may be allowed, with some stimulant, such as aromatic spirits of ammonia, brandy, or small doses of champagne.

Differentiate acute enteritis from acute dysentery.

Pain and tenesmus are well marked in *dysentery*, and the stools are mucoid and bloody. In *enteritis* these symptoms are much less marked; the stools are liquid and may contain some mucus, but no blood. *Amœbæ coli* are found in the amebic or tropical form of dysentery.

Give the treatment of hematemesis.

Absolute rest in bed and withdrawal of all food; small pieces of ice may be allowed if there is great thirst. Tannic acid, 10 gr. every two hours, by the mouth, and opium and ergot hypodermically. If much blood is lost, hypodermoclysis is indicated.

Define hyperchlorhydria. Give the causes, symptoms, diagnosis, and treatment.

Increased secretion of hydrochloric acid during digestion.

Causes.—Improper diet and bad habits of eating; the drinking of large quantities of cold water; excessive indulgence in highly seasoned food; excessive use of coffee, alcohol, and tobacco. Hyperchlorhydria accompanies erosion and ulcer of the stomach; it occurs in chlorosis, and is present in many cases of neurasthenia.

Symptoms.—Pain of a boring or burning character in the epigastrium, coming on from one to three hours after eating, and lasting until relieved by taking alkalis or food. Instead of pain there may be merely a sense of fulness. Thirst, heartburn, acid belching, or pyrosis, and sometimes vomiting, followed by relief from symptoms, occur.

The *diagnosis* is based on the analysis of the stomach-contents. One hour after an Ewald test-breakfast the stomach will be found empty, or only a few cubic centimeters of well-digested contents will be obtained, as the motility is normal or even increased. The total acidity, as well as the free hydrochloric acid, is increased. The latter may be from 50 to 60 after a test-breakfast. Organic acids are not present in uncomplicated cases.

Treatment.—The patient should eat small meals at short intervals. The starches must be restricted, depending on the individual case; some advise an almost exclusive starch diet; others, a proteid diet. Alcoholic beverages, coffee, all highly seasoned and very cold or very hot dishes, and excessive smoking are to be forbidden. Meat, especially mutton, veal, cold ham, poultry, fish, eggs, pure butter, and vegetable oils are recommended because they combine a large quantity of HCl. Vegetables may be allowed.

Medicinal.—The pain and distress at the height of digestion are relieved by giving alkalis with extract of belladonna or atropin. Magnesia is to be preferred to the carbonates because it produces less chlorids. Calcined magnesia and sodium biborate, of each 10 gr., extract of belladonna, $\frac{1}{8}$ gr. two to three hours after meals, may be prescribed. Codein phosphate and strontium bromid are useful adjuvants to relieve pain.

What aids to diagnosis are utilized in the treatment of persons affected with stomach lesions?

Inflation of the stomach or colon to determine the size and position of stomach, or the relation of tumors to these viscera; filling the stomach with water to determine the position of the greater curvature (*Obrastzow's method*); *gastrodiaphany; radiography* after administering bismuth to render the wall opaque; the administration of *test-meals* for the purpose of determining motility of the stomach and the nature of the gastric secretions, the presence of abnormal constituents, etc.

Give the etiology and outline the treatment for acute gastritis.

Causes.—Errors in diet; overindulgence in alcohol; the ingestion of very cold or very hot drinks or strong acid and alkaline substances; exposure to wet and cold; mechanical injuries; in infectious diseases (symptomatic form).

Treatment.—Absolute rest for the stomach and total withdrawal of food until vomiting stops. Cracked ice may be allowed to relieve thirst. Hot applications, mustard plaster, or turpentine stupe to the epigastrium. *Internally*, ipecac in emetic doses may be given. After the first twenty-four hours milk, barley-water, and light broths may be allowed. For the vomiting, calomel, $\frac{1}{12}$ gr., bismuth, and carbolic acid may be given. Opium may even be required if the pain is severe.

Give symptoms and treatment of gastric ulcer.

Symptoms.—Pain and hematemesis are the most important symptoms. (a) *Pain* coming on soon after eating, localized in epigastrium, slightly to the left of the median line and radiating to the back; increased by pressure. A painful point is sometimes present in the back at the level of the tenth to the twelfth dorsal vertebra. (b) *Tenderness* above and a little to the left of the umbilicus. (c) *Hemorrhage*, acute or chronic. The hemorrhage may be quite profuse, or there may be a chronic, imperceptible loss of blood (chronic ulcer). (d) *Hyperacidity* is present in nearly all cases unless there is malignant change or chronic gastritis. (e) *Vomiting* an hour or two after eating and at the height of the pain.

Treatment.—Absolute rest in bed and *rectal feeding* for from ten days to three weeks, depending on the severity of the case, until complete disappearance of pain and tenderness. Later, liquid food for several weeks longer. In less severe cases feeding by the mouth may be begun at once, the diet being restricted to predigested milk, milk and lime-water, buttermilk, broths, and soft-boiled eggs. The return to solid food must be gradual. The two remedies recommended in ulcer of the stomach are *nitrate of silver* and *bismuth*, usually in combination with opium. Carbolic acid, creosote, or cocain is sometimes added to relieve pain. Counter-irritation is sometimes useful. In case of *hemorrhage*, absolute rest, morphin, and suprarenal extract hypodermically; ice-bag to the epigastrium, ice pellets, and tannic acid, 5 to 10 gr., every hour or two, by the mouth. After a thorough trial of medicinal treatment, if the patient does not recover, and in all cases of chronic ulcer, the question of *surgical interference* must be considered.

Differentiate cancer from gastric ulcer.

Cancer.	*Ulcer.*
Rare before forty.	May occur in the young.
Severe anemia and cachexia.	Chlorosis often present.
Pain dull, not much influenced by eating.	Pain sharp, stabbing, or burning, localized in epigastrium and back; occurs soon after eating.
Vomiting delayed.	Vomiting occurs soon after eating.
Hemorrhages small and of characteristic 'coffee-ground' appearance; tarry stools rare.	Hemorrhages profuse; blood bright red; tarry stools.
Hydrochloric acid diminished or absent; lactic acid and Oppler-Boas bacillus in gastric contents.	Hyperacidity. Lactic acid and Oppler-Boas bacillus absent.

What symptoms would lead you to suspect cancer of the stomach?

Obstinate dyspepsia, persisting in spite of rational treatment; persistent pain in the epigastric region, not greatly influenced by eating; progressive

loss of flesh and increasing anemia; vomiting, possibly of coffee-ground material, with other symptoms of dilatation of the stomach; the absence of free hydrochloric acid in the gastric contents and the presence of lactic acid and the Oppler-Boas bacillus; tumor or tenderness in the epigastric region.

Describe the treatment of cancer of the stomach.

If the diagnosis is made early enough, surgical treatment may prove successful; in most cases it is resorted to for the purpose of relieving the pyloric obstruction and alleviating the patient's symptoms. Medical treatment consists in relieving pain in dyspeptic conditions and maintaining the patient's strength. Systematic lavage may be required when there is stagnation of stomach-contents. Opium is usually required. The following tonic mixture is recommended.

℞.	Ext. condurango fld.,	℥ss;
	Strych. sulph.,	gr. $\frac{1}{40}$;
	Ac. hydrochl. dil.,	♏v–xx;
	Elixir gentian.,	q. s. ℥ss.

To be taken in 2 oz. of water, through a tube, after meals.

What are the causes and symptoms of dilatation of the stomach?

Causes.—Atony of the walls with motor insufficiency, due to excessive eating and drinking, is by some regarded as a cause. Pylorospasm from the irritation of fissures, erosions, or small ulcers; scars following ulcer; adhesions to the liver, pancreas, or anterior wall of the abdomen, resulting from inflammatory disease (cholecystitis, gall-stones, pancreatitis, etc.); enteroptosis, causing compression or kinking of the duodenum; foreign bodies.

Symptoms.—General symptoms of dyspepsia, emaciation, and anemia, although the appetite is good. The bowels are constipated; the urine diminished in amount. The pain is of a burning or boring character, not localized. There is epigastric fulness, and pyrosis is complained of. The vomiting is characteristic, occurring usually at intervals of two or more days, according to the degree of stagnation. It is often brought on by change of position as the patient turns over in bed. The vomitus contains food eaten several days or even a week previously, and the act is followed by great relief; the patients often bring on vomiting artificially.

Signs.—The greater curvature is found to be displaced downward by one of the various methods of examining the size of the stomach (Obrastzow's inflation, *x*-ray, etc., see page 388). The finding of food remnants at a time when the stomach ought to be empty is positive proof of a dilatation. The gastric contents contain HCl in excess, except in malignant cases, with sarcinæ, yeast fungus, and lactic acid.

Mention the causes and symptoms of gastralgia.

Causes.—Errors in diet, overwork, mental strain, nervousness, nervous emotion, hyperacidity, and pylorospasm.

Symptoms.—Severe paroxysmal pain in the epigastrium, radiating to the back; most marked when the stomach is empty; relieved by pressure, the ingestion of food, alkalis, or warm drinks.

Give etiology, symptoms, and treatment of dysentery.

Causes.—Hot climates, warm weather, bad hygiene, ingestion of irritating food, exposure to wet and cold, and *Amœba coli* (tropical form). Dysentery occurs in cachectic states, chronic Bright's disease, etc.

Symptoms.—Moderate fever, prostration, abdominal pain and tenderness. The characteristic symptoms are tenesmus and small mucous and bloody stools.

Treatment.—Rest in bed, enforced use of the bedpan, liquid diet, hot applications locally. The intestinal tract should be freed of all irritating material with castor oil and laudanum. Then bismuth salicylate or subnitrate, with salol, carbolic acid, or creosote, should be administered. Ipecac in large doses, 20 to 30 gr. every three to four hours, has been warmly recommended.

Local Treatment.—Enemas of starch water containing laudanum (20 to 30 drops); opium suppositories; ice suppositories; injections of astringent solutions containing nitrate of silver or acetate of lead. Antiseptic solutions: potassium permanganate, 10 gr. to the ounce; formalin, up to 10 gr. to the ounce; bichlorid of mercury, 1:10,000; silver nitrate, 5 to 10 gr. to the ounce; argyrol, 1:1000, have been recommended in amebic dysentery.

Give etiology, symptoms, and treatment of gastro-intestinal catarrh of infancy and childhood.

Causes.—Warm weather, sudden change of temperature, sudden change of weather. The commonest cause is *infected milk.*

Symptoms.—Frequent stools, three to twelve a day, yellow or green, and containing particles of undigested food (upper bowel) and mucus (lower bowel); traces of blood are sometimes found (ulceration). The fever is slight; the child complains of colic and pain.

Treatment.—In infants *withdraw milk* and substitute albumin water and barley water until the green color disappears from the stools and the number of bowel movements becomes normal. In older children restriction of the diet to broths, light soups, milk-toast, etc. Beef-juice or liquid peptonoids are indicated. Change of air is sometimes imperative. *Medicinally,* the treatment is begun with castor oil or calomel, after which bismuth with sodium salicylate must be administered persistently until the diarrhea is controlled. Colonic irrigation, either with hot water or antiseptic or astringent solutions, is very useful.

Outline the area of normal liver dulness.

Anteriorly, in the nipple-line, from the upper border of the sixth rib to the costal margin; in the *axillary line,* from the eighth to the eleventh; in the back, from the tenth to the eleventh. In the median line the upper border is obscured by the cardiac dulness and the lower border lies midway between the xiphoid and the umbilicus. The relative dulness begins at the fifth rib in the nipple-line.

Name the chronic diseases of the liver.

Atrophic and hypertrophic; cirrhosis, cholelithiasis, cancer, amyloid disease, and hydatid disease.

Make a general diagnosis of icterus.

The skin, conjunctivæ, and mucous membrane on the inner side of the lips and under the tongue show the characteristic yellow discoloration. The pulse is slow; the temperature sometimes subnormal; there is itching; the urine is dark and contains bile-pigment; the stools are clay-colored on account of the absence of bile in the intestine.

Differentiate abscess of the liver and cancer of the liver.

In *abscess* the history contains a definite cause—some acute infectious disease or disease of the gastro-intestinal tract, tropical dysentery, etc. The enlargement is uniform, smooth, and usually attended with pain. The temperature is of the septic type, and there are hectic symptoms, sweats, etc. On aspiration pus may be obtained. *Cancer* is a disease of middle life and is secondary to cancer in some other organ. The surface of the liver is nodular, the enlargement is usually painless, and there is marked cachexia.

What diseases may cause occlusion of the common bile-duct?

Catarrhal or suppurative inflammation of the duct; adhesions; cancer or other tumor of the bile-duct. External pressure by tumors of the liver on other organs—stomach, kidneys, pancreas, or omentum; abdominal aneurysm; pancreatic disease, particularly carcinoma.

Foreign bodies within the ducts, gall-stones, inspissated mucus, parasites.

Give the pathology and symptoms of atrophic cirrhosis of the liver.

Pathology.—At first the liver is large from hyperemia; later it becomes small, firm, gray in color, and covered with nodules ('hob-nail liver'). On section, small and large bands of connective tissue are seen, and the surface appears nodular. The overgrowth of connective tissue causes constriction of the branch of the portal vein and atrophy and degeneration of the liver-cells.

Symptoms.—The symptoms of portal obstruction and gastro-intestinal catarrh, such as coated tongue, fulness and distress after eating, loss of appetite, flatulence, constipation, and dark urine. Later enlargement of the abdominal veins (*caput medusæ*), hemorrhoids, ascites, swelling of the feet, hemorrhages from various mucous membranes, enlargement of the spleen. The liver is at first enlarged, but later contracted, and the hepatic dulness accordingly diminished.

What are the symptoms of obstruction of the ductus communis choledochus?

Jaundice, chill, fever, sweating, and paroxysmal attacks of hepatic colic. The jaundice may be intermittent or remittent. The liver, owing to the obstruction, becomes enlarged, and firm and smooth on palpation; the gall-bladder is not enlarged. The symptoms are often intermittent, owing to ball-valve action of a single gall-stone. There may be intermittent fever. The jaundice is progressive.

Give the symptoms and treatment of catarrhal jaundice.

Symptoms.—The disease begins with dyspeptic symptoms, such as anorexia, coated tongue, epigastric fulness, and sometimes vomiting and diarrhea. The characteristic yellow discoloration soon develops in the

skin, conjunctivæ, and mucous membranes of the mouth. The urine is dark and contains bile-pigment; the stools are clay-colored. Sometimes there is slight fever, and the liver may be swollen and tender.

Treatment.—Liquid diet, rest, mild laxatives, such as calomel or phosphate of sodium. The salicylates are recommended. Hot applications may be applied over the liver.

What are the causes of cirrhosis of the liver?

The abuse of alcohol; chronic diseases in which the composition of the blood is altered, such as syphilis, gout, malaria, and tuberculosis; chronic heart and lung disease; inflammation of the bile-ducts.

Outline the treatment of cirrhosis of the liver.

Alcohol must be prohibited; the *diet* should be light and nutritious. If there is gastric catarrh, such remedies as nitrate of silver and bismuth, and antiseptics like creosote or a salicylate of sodium or bismuth, are indicated. Mineral waters, especially bitter waters, are useful. Iodid of potassium is sometimes recommended. *Ascites* must be combated by occasional saline purges and diuretics, such as digitalis and caffein. Niemeyer's pill (calomel, powdered digitalis, powdered squill, of each, 1 gm.) is a favorite diuretic in cirrhosis of the liver.

What are the clinical manifestations of biliary calculi?

While the stone remains in the gall-bladder there are no symptoms. The passage of a gall-stone is attended by *hepatic colic*. It is characterized by agonizing pain over the liver, often radiating to the right shoulder. The pain is paroxysmal and causes more or less collapse. The patient usually vomits, at first stomach-contents and later bile. The urine is highly colored and sometimes suppressed. There is marked tenderness in the epigastric region, which may be slightly swollen. The attacks may recur several times until the stone has been passed; sometimes the attack is preceded by chill. A slight temporary jaundice usually develops after the attack, and the urine contains bile. The stone may fall back into the gall-bladder and all symptoms subside, or it may be passed into the bowel and be recovered from the feces; or it may become impacted. *Impacted gall-stone* usually, but not always, causes complete obstruction of the duct, depending on the position and shape of the stone; sometimes the bile can be forced through or around it, or a ball-valve action occurs, with intermittent jaundice and other symptoms of obstruction.

Describe the treatment of biliary lithiasis.

The treatment of the *attack* consists in relieving the pain, which can be done only by hypodermic injections of morphin; chloroform inhalations may be administered first if the pain is very intense; hot fomentations over the liver sometimes help to relieve the pain. If the condition becomes *chronic*, the jaundice persists, and intermittent or Charcot's fever develops, surgical intervention should be sought. The *prophylaxis* consists in regulating the diet, from which sweet and starchy food should be excluded, and insisting on exercise and favorable hygienic surroundings. Tight lacing in women should be forbidden. The skin, kidneys, and the bowels must be kept active.

What are the symptoms of hepatic abscess? In what climates is hepatic abscess most likely to occur?

The constitutional symptoms are hectic fever, sweats, and chills (hectic symptoms). The liver is uniformly enlarged, painful, and tender; fluctuation is detected in rare instances, and jaundice may occur from obstruction of the bile-ducts. On aspiration pus may be obtained with a needle in cases of single abscess. The *diagnosis* is based largely on the history. Abscess of the liver is most common in hot climates, tropical dysentery being the most common cause.

Give the treatment of suppurative hepatitis.

Evacuation and thorough drainage of the abscess. If the abscesses are multiple and surgical interference is not justified, the case must be treated as one of ordinary septicemia.

Give the symptoms of acute general peritonitis.

The onset may be sudden or gradual, depending on the cause; the disease begins with a *chill* and intense abdominal pain, which is at first localized and rapidly becomes general. It is aggravated by movement and pressure. The patient assumes a characteristic attitude, with the knees drawn up to relieve tension of the abdominal muscles. The respirations are shallow and accelerated, breathing, and especially coughing, being very painful. The *temperature* rises to 104° to 105° F., with a marked difference between morning and evening temperatures. The pulse is rapid and hard ('wiry'). There is vomiting, first of stomach-contents and then of bile. Later the vomiting is replaced by passive regurgitation; the bowels are constipated, from paralysis of the intestines.

What are the physical signs of acute general peritonitis?

Hippocratic facies (sunken eyes, pinched features, anxious expression). The tongue is dry, cracked, and red; the abdomen is distended, extremely sensitive to touch, and tympanitic on percussion; the apex-beat may be displaced to the fourth interspace; the splenic and liver dulness is diminished or obliterated. The liver dulness is never entirely obliterated in the axillary region. There is rigidity of the muscle overlying the primary lesion. The pulse is rapid,—110 to 150,—feeble, and thready. In the early stage it is small and hard, and described as wiry.

Give the signs and symptoms of floating kidney.

Aside from neurasthenia, which is always present, the *symptoms* are due to the dragging of the kidney on blood-vessels and nerves and to pressure upon adjacent organs. The pain comes on in attacks, known as *Dietl's crises*, and is sometimes accompanied by nausea and vomiting. During a crisis the urine is scanty and hydronephrosis may develop; as the kidney returns to its place the twisting of the ureter is relieved and a copious discharge of urine takes place. The kidney can be felt by *bimanual palpation*, coming down during deep inspiration and slipping back into place as the diaphragm returns to the expiratory position. The patient may be aware of the presence of a tumor in the abdomen. Usually the signs of enteroptosis are present also; there is diastasis of the recti muscles (Weber's sign), and the eleventh rib is movable (Stiller's sign). Jaundice is sometimes present.

Differentiate between acute generalized peritonitis and acute intestinal obstruction.

The history, especially in regard to the action of the bowels, is important. In peritonitis stercoraceous vomiting occurs late, if at all; the pain and tympanites are more general. A tumor may be palpable in intestinal obstruction, or the discharge from the rectum may reveal invagination as the exciting cause.

Give the causes and symptoms of ascites and tell how to recognize by what disease it is produced.

Causes.—(a) General: disease of the heart and of the kidneys. (b) Local: inflammation of the peritoneum (simple, tuberculous, or cancerous); portal obstruction from disease of the liver (cirrhosis) or of the portal vein (compression or inflammation); abdominal and pelvic tumors. In *renal* disease the urine will show the characteristic findings, and edema will be present in other parts of the body, particularly the face. Ascites due to *cardiac* disease is recognized by the physical signs in the heart, and usually the presence of dropsy and edema in the feet (cardiac dropsy). *Tuberculous peritonitis* is recognized by the history of the case, the presence of some elevation of temperature, and often the physical signs of a tuberculous focus elsewhere in the body, especially the lungs. In *cancer* the age, the history, the appearance of cachexia, and the anemia will be helpful. Disease of the *liver*, especially cirrhosis, is readily recognized by its well-known symptoms of portal obstruction and gastro-intestinal catarrh. *Abdominal tumors* can be recognized by palpation, percussion, and, in the case of women, by vaginal examination; the history is also useful.

What diseases are liable to occur in the right inguinal region?

Appendicitis, floating kidney, disease of the liver and gall-bladder, and inflammation or tumor of the tube and ovary.

Give the symptoms of appendicitis.

In an acute case the *onset* is sudden, with pain in the abdomen, at first localized at McBurney's point, and later radiating in various directions toward the umbilicus, the epigastrium, or to the right or left side of the body. The *fever*, which is usually moderate, follows the pain. The *pain* is paroxysmal in character, and sometimes described as colicky, although it is not usually so severe as true intestinal colic; sometimes it is very slight. There is sometimes nausea and vomiting; the pulse frequency is out of proportion to the fever. The bowels may be constipated or relaxed. The tongue is coated, and there is absolute anorexia; the expression of the face is anxious and suffering; the patient usually lies on his back, with the right thigh flexed on the abdomen. *Tenderness over McBurney's point* is obtained on pressure with the finger; rarely the swollen appendix is palpable. The right *rectus muscle is rigid* ('on guard'); sometimes the left rectus also. Percussion may reveal a change of note over the region of the appendix, particularly if the abscess has formed. The important diagnostic points are: History of onset with pain as the first symptom before the development of fever; marked tenderness and pain over McBurney's point; rigidity of the right rectus muscle; the characteristic expression and attitude; the absence of symptoms and signs of thoracic disease.

Describe and locate the pain in (a) appendicitis; (b) renal calculus; (c) gall-stones; (d) ovaritis; (e) cystitis.

(a) In the right iliac region, radiating to the umbilicus, to the epigastrium, or to either side. (b) In the right or left lumbar region, radiating to the penis and inside of the thigh, or corresponding structures in the female. (c) Over the gall-bladder, radiating to the epigastrium or to the right shoulder, sometimes to the back. The pain may be at the tip of the ninth rib (Mayo Robson's point). (d) In the ovarian and sacral regions. (e) Over the bladder, increased by movement and by the erect position, and relieved by evacuation of the bladder; pressure on the base of the bladder through the vagina causes pain.

Differentiate appendicitis from enteric fever.

This is very difficult during the first few days of the disease, before the Widal reaction can be obtained. The differential diagnosis must be based on the presence in *appendicitis* of marked pain, tenderness, and board-like rigidity over McBurney's point, the more sudden onset, and the absence of a typical typhoid temperature-curve. *Enteric fever* begins more gradually; there is a history of prodromes, particularly headache and pain in the back and limbs; the tongue is more heavily coated, and the breath has a characteristic odor in typhoid fever. The appearance of rose-spots, the Widal reaction in the blood-serum, and splenic enlargement on the fifth to the seventh day, establish the diagnosis of typhoid fever.

Differentiate peritonitis and enteritis.

The constitutional symptoms, the fever, pain, and mental disturbance, are much greater in *peritonitis*. The abdomen is distended and very tender to the touch, or an effusion may be present. In nearly every case there is marked constipation. In *enteritis* there is diarrhea; distention is rarely marked, and there is no abdominal rigidity. Vomiting, which is usually present in peritonitis, is absent in enteritis.

Differentiate intestinal colic, uterine colic, and renal colic.

Intestinal Colic.—The pain is diffuse or referred to the umbilical region, and very severe, doubling the patient up. It is relieved by pressure and by the free discharge of flatus. The attack, as a rule, comes on suddenly and does not last long, and there is a distinct history of some dietetic indiscretion.

Uterine Colic.—The pain is localized in the pelvis and somewhat of an intermittent, contractile character. There is usually a history of some uterine disorder.

Renal Colic.—The pain begins in the lumbar region and shoots down the ureter to the side of the penis or labium. The testicle on the painful side is retracted. The attack is often accompanied by nausea, vomiting, and profuse sweating, and is relieved by the passage of gravel or calculi.

What should be done to give relief in intestinal obstruction?

The treatment is *surgical;* purgatives are counterindicated, and opium should be given only after the diagnosis has been established. Persistent vomiting may be controlled with the use of the stomach-tube. Atropin in large doses has been recommended, but the method has but few supporters.

High irrigation has been suggested in cases of intussusception in children, and sometimes proves successful.

Describe the physical signs of simple ascites and those of ovarian dropsy.

Simple Ascites.	*Ovarian Dropsy.*
In the dorsal position the umbilical region appears flat, while the lateral portions bulge.	The accumulation is local, confined to the ovarian region, and does not change with the position of the patient.
Fluctuation is present. Tympany is obtained over the umbilical region, and flatness in the flanks.	Fluctuation is absent.
The results of percussion change with the position of the patient.	
Absence of tumor.	Vaginal examination may reveal the presence of a tumor.

Give the etiology of tuberculous peritonitis and the treatment.

Childhood, male sex, and negro race are predisposing factors. It is usually associated with other forms of tuberculosis—intestinal, mesenteric, pulmonary, etc. It is often secondary to tuberculous ulcer of the intestine, or may be derived from the pleura or pericardium by extension. The treatment is supportive, as in other forms of tuberculosis. Incision of the abdomen, followed by thorough drainage of the cavity and mechanical irritation to bring about adhesions, is recommended.

Mention and differentiate the species of tenia.

There are three species of tenia which occur fully developed in man: The *Tænia solium*, or pork tapeworm, the *Tænia saginata*, or beef tapeworm, and the *Bothriocephalus latus*, which is derived from fish. The body of a tapeworm consists of a head or rostellum, and a large number of segments or proglottides, varying in size in different portions of the body.

Tænia solium, also called the armed tapeworm, has a rostellum supplied with two rows of hooklets; the head is quadrilateral and has four sucking discs.

Tænia saginata, or unarmed tapeworm, the commonest found in man, has a head or rostellum surrounded by four suckers, with a rudimentary sucker in the middle. It is longer than the pork tapeworm, and the proglottides are larger, measuring from 8 to 10 mm. in width and about 18 mm. in length.

Bothriocephalus latus attains a length of from 5 to 6 m. The head is elongated and supplied with two grooved suckers, one on each side. The proglottides are broader than they are long, and, when mature, show a characteristic rosette arrangement of the uterus.

The *remedies* recommended are pomegranate root, *male-fern*, pumpkin seeds, thymol, turpentine, and chloroform. The most reliable drug is the oleoresin of male-fern, or the French preparation, *pelletierin*, which contains its active principle. The dose of the oleoresin of male-fern is 2 dr., repeated, if necessary, in two hours. The night before the vermifuge is administered the patient should be given a purge. The anthelmintic is administered immediately after breakfast the next morning, and this is followed by another purge, either saline or oil, three hours later, when the parasite will be expelled.

How would aneurysm of the abdominal aorta affect the dorsalis pedis artery pulse as compared with the radial pulse?

Theoretically, the pulse in the dorsalis pedis artery would be small and delayed as compared with the radial pulse.

State possible causes of dropsical conditions of the abdomen and lower extremities.

(a) Disease of the heart, liver, or kidneys; sometimes severe anemia. (b) *Local:* pressure in the abdomen due to the presence of a tumor, such as the pregnant uterus, malignant disease, aneurysm, etc.

What are the stages of malarial intermittent fever?

First, the cold stage or stage of chill; second, the hot stage or stage of fever; third, the sweating stage.

Describe malarial fever.

There are two forms: the *simple intermittent* and the irregular remittent, or continuous, also called *estivo-autumnal.*

The simple intermittent may be *tertian* or *quartan*, or the plasmodia may invade the blood in more than one series, resulting in *double-tertian*, or *double* or *triple quartan*, or even combinations of these.

A paroxysm of *intermittent malarial fever* begins with a *chill*, accompanied by headache, coldness of the surface of the body, with cyanosis, although the internal temperature is high (104° to 105° F.). The chill lasts from a few minutes to an hour or two, and may be attended by vomiting. This is succeeded by the *hot stage.* The patient feels hot, the face is flushed, the eyes are injected, and the pulse is full and rapid. The temperature may go up as high as 105° to 106° F. During this stage the patient complains of severe pain in the head, back, and limbs; it lasts from one to five hours. During the *third stage* the pain and discomfort gradually diminish, the fever subsides, and the patient breaks out into a free perspiration, after which he usually falls asleep, and when he wakes feels fairly well. The entire duration of a malarial paroxysm is about twenty-four hours.

In the *remittent* or *estivo-autumnal* form the fever is continuous, with daily remissions, the maximum temperature being from 103° to 106° F. The pulse is full and rapid, the urine scanty, and the patient complains of pain in the head and limbs. Sometimes paroxysmal febrile attacks are observed. The spleen is enlarged; jaundice may be present, and sometimes delirium.

Give the causes of malaria, the varieties of organisms found in each form, and state how the disease is most likely conveyed.

Favoring conditions are: a warm climate, summer season, marshy ground, or the presence of stagnant water. The *cause* of malaria is the *Plasmodium malariæ*, discovered by Laveran in 1880. Three varieties are recognized: First, the plasmodium of simple tertian intermittent fever; second, the plasmodium of simple quartan intermittent fever, and third, the plasmodium of estivo-autumnal fever. Malaria is carried solely by a species of mosquito, the *anopheles.* When a mosquito of this species has sucked the blood of a malarial patient, it becomes capable, after a certain number

of days, of infecting those who are subsequently bitten by it with malarial fever; it is said to be the *intermediate host.* The theory that malarial infection can be conveyed by water or through the air is now abandoned.

Outline the treatment of malarial fever.

Prophylaxis.—Surface drainage and the removal of pools of stagnant water. Stagnant water in tanks, barrels, etc., must be rendered innocuous with coal-oil, or the receptacles must be screened with mosquito netting. Prophylactically, *quinin* should be given in doses of 1 to 3 gr. three times a day.

Curative Treatment.—In ordinary cases the paroxysm requires no treatment beyond making the patient comfortable. If the pain is very severe, full doses of opium or potassium bromid may be given. If there is a suspicion of *pernicious malarial fever*, 30 gr. of quinin should be administered in one dose during the cold stage. During the intermission quinin is administered for the purpose of averting the succeeding attack. Three doses of 10 gr. each are administered ten, six, and two hours before the time of the expected paroxysm, respectively. If the treatment is successful and no paroxysm takes place, no more quinin is administered on that day; but the same treatment is resumed in preparation for the next paroxysm. If the attacks have been controlled, the administration of quinin is continued in so-called tonic doses, 5 gr. three times a day for a week, and after that 2 gr. three times a day for one month longer.

If 30 gr., administered as above, fail to avert the attack, the same quantity of quinin should be given in two doses of 15 gr. each, seven and three hours before the expected paroxysm, or in one dose of 30 gr. three hours before the expected paroxysm.

Administration.—Sulfate or bisulfate of quinin or bimuriate of quinin and urea is selected, the two last being the more soluble. The drug is preferably given in the form of dry powder inclosed in gelatin capsules or wafers; it can also be given by the rectum, when the dose should be double, or hypodermically in urgent cases, when from $\frac{1}{4}$ to $\frac{1}{2}$ the dose per mouth is to be administered.

In chronic forms of malaria arsenic in full doses in the form of arsenic trioxid or Fowler's solution is indicated. During convalescence quinin, iron, and strychnin are given in combination to combat the anemia.

DISEASES OF THE KIDNEYS AND BLADDER

What are the different steps in the examination of the urine?

Determine the quantity, color, presence or absence of turbidity, chemical reaction, specific gravity.

Filter a portion of the specimen and test the filtrate for the presence of albumin and sugar. For *albumin* boil the upper portion of the urine in a test-tube; if a cloud forms, it may be due to the presence of albumin or phosphates; if phosphates, the addition of a few drops of acetic acid or nitric acid will clear the cloud; while an albuminous cloud will persist. *Glucose* is tested for by means of Fehling's reduction test. About 2 to 3 cc. of diluted Fehling's mixture is placed in a test-tube and heated, and the filtered urine added drop by drop. If the urine contains sugar, a bright yellow cloud will be formed.

Microscopic Examination.—Some of the unfiltered urine is now placed in the centrifugator and examined under the microscope for the presence of *casts*, epithelial cells, blood-cells, pus-cells, and *unorganized sediments*, uric-acid crystals, etc.

If albumin or sugar is present, a *quantitative* estimation should be made. Additional substances to be tested for are indican, bile-pigment, chlorids, urea; the *diazo reaction* is obtained in a number of infectious diseases, especially typhoid fever.

What casts are frequently found in albuminous urine and what do they denote?

Hyaline—chronic interstitial nephritis, less often in acute inflammations; occur also in puerperal eclampsia, in catarrhal jaundice, cancer, anemia, and, according to some, in normal urine.

Granular—usually in acute Bright's disease, also in chronic parenchymatous nephritis (large granular casts), and puerperal eclampsia.

Epithelial—indicate an acute process; occur in acute parenchymatous nephritis, particularly the form seen in scarlet fever, typhoid, pneumonia, and other infections.

Blood—acute forms of nephritis, especially traumatic and toxic; do not indicate permanent structural change.

Waxy or *amyloid*—give the amyloid reaction. They occur in chronic and occasionally in acute nephritis; in phthisis, amyloid disease, and septic processes.

Urate casts or *pseudocasts* are conglomerations of urates, not true casts; they are found in renal congestion, plethora, rheumatism, and tonsillitis.

What conditions increase the amount of uric acid in the urine?

Exercise; a diet rich in carbohydrates and fat; febrile and sweating diseases, such as phthisis, diseases of the liver, leukemia, malaria, diabetes, scurvy, rickets, and gout (after an attack).

Give the causes of deficiency in excretion of urea.

Nephritis, organic diseases of the liver, sweating diseases, anemia, starvation, acute gout, and chronic rheumatism.

Describe pyuria and state its import.

Pus in the urine. It indicates suppuration in some part of the genito-urinary tract or rupture of an abscess into the tract. *Pus derived from the kidney* is intimately mixed with the urine, and the latter has an acid or neutral reaction; *pus from the bladder* is less intimately mixed with the urine, which is usually alkaline. Pyuria occurs in urethritis, cystitis, pyelitis, and pyelonephritis; in salpingitis, extra-uterine pregnancy, psoas abscess, etc.

Name the causes of chronic or persistent hemorrhage from the kidney.

Alterations in the blood, as in septic fevers, purpura, malaria, scurvy; congestion of the kidney in chronic disease of the heart, lungs, or liver; stone in the kidney; tumors and tuberculosis of the kidney.

Make a differential diagnosis between renal colic and hepatic colic.

Renal Colic.	*Hepatic Colic.*
Pain begins in the back and radiates down the ureter into the penis, testicle, and thigh.	Pain over the liver radiating to the back and to the right shoulder.
Retraction of testicle on affected side.	Not present.
Hematuria.	Urine contains bile.
No jaundice.	Jaundice may be present.
No relation to the taking of food.	Usually occurs an hour or two after eating.
Vomiting may or may not occur at the onset.	Vomiting persistent.
Stone may be found in the urine.	Stone may be found in the stools.

Describe the prophylaxis and treatment of nephrolithiasis.

Prophylaxis.—Regulation of the diet. If the urine is acid, citrate of potassium and carbonated lithium, well diluted, should be given several times a day; mineral waters may also be ordered. In the case of an alkaline stone, benzoic or boric acid is administered instead.

Treatment of the Attack.—The pain will require morphin and atropin hypodermically. Hot applications to the lumbar regions or hot baths; the patients should be urged to drink water freely. If the pain is very severe, chloroform or ether may be administered by inhalation. Nephrolithotomy is sometimes necessary.

Name a medicine which affects the urine as to color and odor.

Santonin gives the urine a yellow color; *turpentine* imparts to it the odor of violets.

What are the symptoms of acute parenchymatous nephritis?

In mild cases there is but little constitutional disturbance; the more severe cases may begin with chill, pain in the limbs, fever, and headache. There is hypertrophy of the left ventricle, with increased blood-pressure and accentuation of the second aortic sound; later, dropsy, with effusion into the various serous cavities, and anemia develop. Among special symptoms are neuritis, dyspnea, stupor, and convulsions, nausea and vomiting, etc.

Urine.—In mild cases, such as the nephritis of typhoid fever, pneumonia, diphtheria, scarlet fever, and the like, the quantity is diminished. There is frequently anuria; the color is dark, the specific gravity is high, a small amount of albumin is present, with epithelial blood-casts and sometimes blood. The severe cases show a large amount of albumin and an abundance of hyaline, granular, epithelial, and blood-casts, with free blood-cells and renal epithelium.

Give the symptoms of acute exudative nephritis.

The clinical symptoms are those of acute Bright's disease. In this special form there may be high fever and extreme prostration, rapid emaciation, an early development of the typhoid state, with headache, delirium, great restlessness, and stupor. The dropsy is not marked. It is a very fatal form of nephritis and resembles acute meningitis. The *diagnosis* is

based on the findings in the urine, which contains large numbers of red and white blood-cells, granular, epithelial, and blood-casts, and renal epithelium.

What are the causes, clinical course, and complications of chronic interstitial nephritis?

Causes.—Chronic endocarditis, alcohol, lead, the poisons of gout, syphilis, and malaria.

Course.—The disease sets in late in life and progresses slowly, causing no symptoms at first. The occurrence of uremia or apoplexy is often the first indication of its presence. The only clinical *symptoms* may be loss of flesh and strength. Edema is usually absent.

The *complications* are uremia, pulmonary symptoms, so-called *renal asthma*, gastro-intestinal disturbance, cirrhosis of the liver, intestinal catarrh, neuroretinitis causing dimness of vision and blindness, arteriosclerosis, hypertrophy of the heart, and apoplexy.

Enumerate the points of value in the diagnosis of a case of chronic interstitial nephritis.

Accentuation of the second aortic sound, increased blood tension, hypertrophy of the left ventricle, atheroma of the arteries, habitual headache, vertigo, diarrhea, anemia, increased amount of urine of low specific gravity containing a few hyaline casts. Albumin may or may not be present or may be present only at times.

What are the urinary findings in chronic interstitial nephritis?

The quantity is increased, the color is clear, and the specific gravity low; albumin may be present in small amounts or altogether absent; or it may be found only at times. A few hyaline casts are usually present, and sometimes a few red blood-cells.

What is uremia and how should it be treated?

Uremia is a condition resulting from the retention of toxic materials in the blood which should have been eliminated by the kidneys. Administer croton oil, 1 or 2 drops; elaterium, $\frac{1}{4}$ gr.; or blue mass, 5 gr., at once. *Venesection*, followed immediately by intravenous infusion or hypodermoclysis, is of great value. The patient is then sweated by a *hot-water bath*, followed by dry pack, hot-air or vapor bath, reinforced with a hypodermic injection of pilocarpin, $\frac{1}{12}$ to $\frac{1}{8}$ gr., depending on the patient's strength. The convulsions may be controlled with chloral, morphin, or inhalations of chloroform.

Give symptoms of uremia and differential diagnosis from alcoholic narcosis.

The *symptoms* of uremia are extremely variable: headache, vertigo, delirium, convulsions, coma, sudden blindness, and temporary paralysis from edema of the brain or cord. Dyspnea and Cheyne-Stokes breathing, obstinate vomiting, and purging may be present. The important diagnostic points are dryness of the skin, urinous odor of the breath, and low specific gravity of the urine, which usually contains some albumin and is deficient in urea. The temperature is usually subnormal, but may rise during convulsions.

The differential diagnosis of uremic coma from *alcoholic narcosis* is exceedingly difficult. In uremic coma the odor of the breath is urinous and the second aortic sound is accentuated; the urine is scanty and contains albumin; the temperature may be above or below normal; the pupils are usually small, and there is no evidence of any other cause. Alcoholic narcosis may be recognized by the history and the odor of alcohol on the breath or in the stomach-contents. The patient can generally be aroused by shouting in his ear or pressing on a tender point, such as the supra-orbital notch.

If summoned to a middle-aged person discovered in a comatose condition, explain how to recognize upon what disease the condition depends, and give treatment for the uremic type of coma.

The conditions to be considered are: (1) apoplexy; (2) uremic coma; (3) alcoholic narcosis; (4) opium-poisoning; (5) diabetic coma; and (6) thermic fever.

(1) *Apoplexy* is recognized by the history, the condition of the arteries, the evidences of paralysis, rigidity or flaccidity on one side of the body, conjugate deviation of the head and eyes, flapping of one cheek in respiration, stertorous or Cheyne-Stokes breathing, and a difference between the temperatures of the two axillæ.

(2) *Uremic Coma.*—See previous question.

(3) *Alcoholic Narcosis.*—By the history, the odor of the breath, the absence of other cause, and the fact that the patient can be roused by shouting in the ear or pressing on a tender point.

(4) *Opium-poisoning.*—By the history and odor of laudanum on the breath, pin-point pupils, and slow and shallow respirations.

(5) *Diabetic Coma.*—By the history of diabetes, the sweetish odor of the breath, the finding of glucose in the urine, and subnormal temperature.

(6) *Thermic Fever.*—This will be recognized by the extremely high body temperature, the state of the weather, or the temperature of the room in which the patient is found, and the absence of other causes.

Define hydronephrosis. State its causes and describe its treatment.

Distention of the pelvis of the kidney with an accumulation of watery fluid resulting from obstruction in some part of the genito-urinary tract, the ureter, bladder, or urethra.

Causes.—(1) Congenital stricture of the ureter; (2) inflammatory stricture of the ureter or urethra; (3) impacted calculus; (4) tumors pressing on the ureter; and (5) movable kidney.

Treatment.—Depending on the cause; *position* and *massage* may induce evacuation of the fluid. If the sac is large, it should be aspirated; in some cases a *surgical operation* to establish a fistula or extirpate the organ may be necessary.

What is the prognosis of suppurative nephritis secondary to cystitis? Outline the treatment of the condition.

The prognosis is extremely grave and the treatment is surgical.

What are the symptoms of cystitis and how is it to be distinguished from simple irritability of the bladder?

Pain over and behind the pubes, in the sacral region, peritoneum, and thighs; constant desire to urinate; intensely painful micturition, accompanied by tenesmus; the urine is cloudy from the presence of mucus, pus, and blood, and contains shreds of lymph. In severe cases there are constitutional disturbance, delirium, etc. A mild case of cystitis is distinguished from irritability of the bladder by the characteristic findings in the urine.

Differentiate acute cystitis and acute prostatitis.

The symptoms of the two conditions are similar, and the diagnosis must be made by exploring the rectum with the finger and finding that the gland is enlarged and tender, and by the conditions of the urine.

Differentiate between pyelitis and cystitis.

Cystitis is distinguished from pyelitis by the absence of lumbar pains, the alkalinity of the urine, which contains bladder-cells, besides pus and albumin, and by the symptom of frequent and painful micturition. In pyelitis the urinary sediment is also quite flocculent and contains renal epithelial cells; in cystitis the sediment is ropy, and not readily broken up by shaking. In doubtful cases catheterization of the ureters should be resorted to.

Describe the treatment of cystitis.

Rest in bed; light diet; attention to the bowels. *Internally*, a large number of remedies have been recommended—flaxseed tea with potassium citrate, copaiba, senega, triticum repens; if the urine is alkaline, benzoic or boric acid. *Counterirritation* or leeches to the suprapubic region is recommended. To control the pain and vesical irritation a *hot hip-bath* may be tried; opium with extract of hyoscyamus is usually required. In acute cases irrigation is *counterindicated.* When the condition becomes chronic, irrigations with sedative, astringent, and antiseptic solutions are recommended. The substances used are the silver salts (argyrol), permanganate of potash, boric acid, and the like.

THE ANEMIAS

Define anemia and chlorosis.

Anemia is a condition in which the blood is deficient either in its bulk or in certain of its constituents. Anemia is broadly divided into *primary* (essential or idiopathic) and *secondary* anemia. *Chlorosis* is a form of primary anemia of unknown causation, characterized by marked diminution of the hemoglobin (*oligochromemia*) without corresponding reduction in the number of red cells. It occurs almost exclusively in young girls.

What are the causes of secondary anemia?

(1) *Hemorrhage*, either traumatic or spontaneous, after injuries or operations; the rupture of a blood-vessel or aneurysm, ulcer of the stomach, postpartum hemorrhage, etc.

(2) *Wasting diseases*, such as chronic Bright's, rheumatism, septicemia, cancer, suppuration in any part of the body. Hyperlactation also belongs to this group.

(3) *Inanition*, either from lack of food-supply or inability to assimilate, as in chronic dyspepsia, diseases of the esophagus, cancer, etc.

(4) *Toxic agents*, such as lead, mercury, arsenic, and the poison of syphilis and malaria.

Give the symptoms and blood picture of chlorosis.

There is a notable absence of emaciation; the patients are often quite fat. The color is a peculiar lemon yellow. The appetite is capricious; the bowels are obstinately constipated; there is some gastro-intestinal disturbance, with dyspeptic symptoms and hyperacidity; the patient complains of palpitation and breathlessness. A systolic (hemic) murmur is usually present at the base or apex, more frequently at the base, and a humming-top murmur (*bruit de diable*, venous hum) is heard over the jugular veins; the pulse is soft and full. In some cases there is fever.

Blood.—The drop of blood appears pale; the number of red cells is normal or but slightly diminished—usually not more than 80 per cent.; the reduction of hemoglobin is disproportionately great (low color index); the leukocytes are slightly increased in number. There is some poikilocytosis; the red blood-cells are pale and smaller than normal; nucleated red cells or normoblasts are occasionally found.

What is the blood picture of an ordinary secc ndary anemia?

Moderate reduction of red blood-cells, with some poikilocytosis; the leukocytes are slightly increased, especially the polynuclear forms. The reduction of hemoglobin is slightly greater in proportion than the reduction of red cells.

What is progressive pernicious anemia?

A fatal form of primary anemia characterized by marked decrease in the number of the red blood-cells, a relatively high percentage of hemoglobin (high color index), leukopenia, fatty degeneration of internal organs, and a peculiar lemon-yellow color of the skin.

Give a brief description of the pathology and blood picture in progressive pernicious anemia.

The body is not emaciated; the blood is dark in color; the fat is yellow. Hemorrhages occur in various mucous membranes. The heart is large, flabby, and usually empty. The muscle shows marked fatty degeneration. The stomach may be atrophied. The liver is enlarged and fatty. Iron is found in excess in the liver, in the spleen, which latter is not enlarged, and in the kidneys. The bone-marrow is red and 'lymphoid' and contains gigantoblasts. Posterior sclerosis is present.

Blood.—The number of *red blood-cells* is *diminished* to one-fifth or less of the normal; the *hemoglobin* is relatively *high*, though absolutely very much diminished; the number of leukocytes is either normal or diminished (*leukopenia*), with an increase of the mononuclear and decrease of the polynuclear elements. The size of the red blood-cells is very variable: some

are very large and ovoid—so-called *megalocytes*—while others are abnormally small; nucleated red blood-cells, *normoblasts*, and *gigantoblasts* are present.

Give the treatment and prognosis of progressive pernicious anemia.

The prognosis is absolutely unfavorable. The treatment is the same as that of leukemia.

Describe leukemia and mention the pathologic changes occurring in this disease.

The disease is characterized by a marked increase in the number of white blood-cells and in a disturbance of the normal proportions of the various forms, and by changes in the spleen, lymphatic glands, and bone-marrow. Two forms are distinguished:

(a) *Splenomedullary leukemia*, in which the spleen is greatly enlarged and elements derived from the bone-marrow (*myelocytes*) are chiefly increased in number. (b) *Lymphatic leukemia*, in which the lymph-glands especially are enlarged and the blood shows an increase of *lymphocytes*, the elements derived from the lymph-glands.

The alkalinity of the blood is diminished, the fibrin is increased, and the specific gravity is somewhat lower. The diagnosis is based on the blood picture. In the splenomedullary form the number of leukocytes is greatly increased, so that the proportion of white to red cells may be 1:10 or 1:5, instead of the normal proportion of 1:500 or 800. The small *lymphocytes* are relatively diminished, although absolutely increased. The *eosinophile leukocytes* are actually and relatively increased and form a prominent feature in the blood-slide. The polynuclear neutrophiles are normal or relatively diminished. The characteristic feature of leukemic blood is the presence of *myelocytes*, which are not found in normal blood. Myelocytes are derived from the marrow; they are larger than the large mononuclear leukocytes and the protoplasm is filled with *neutrophilic granules*. *Nucleated red blood-corpuscles*, either normoblasts or gigantoblasts, are present. The reduction of red blood-cells is moderate; that of hemoglobin, relatively greater.

In lymphatic leukemia the leukocytosis is never so great and affects only the *lymphocytes*, all other forms being relatively greatly diminished. Either the large or the smaller forms of leukocytes may predominate. Myelocytes are not present, and eosinophiles and nucleated red blood-corpuscles are rare.

Describe the treatment of leukemia.

Arsenic in large doses, up to 20 minims of Fowler's solution three times a day, or until signs of intolerance make their appearance, is the only drug that has any effect on the disease. The *diet* must be nutritious; raw, red bone-marrow with equal parts of glycerin may be added. Some benefit may be derived from oxygen inhalations.

Splenectomy has been performed in a few cases, with a mortality of about 45 per cent. Direct transfusion of arterial blood has not proved successful in leukemia and pernicious anemia, although it may be followed by temporary improvement.

What is hemophilia?

An hereditary tendency to uncontrollable hemorrhage, either spontaneous or from slight wounds; the coagulation of the blood is retarded—sometimes it is delayed from thirty to fifty minutes.

Treatment.—Bleeders should be guarded from injury, and operations of all sorts avoided; the female members of the family should not marry, as it is through them that the tendency is propagated. When the hemorrhage is from a free surface, it may be controlled with rest, compression, and local applications of ice, and if these means fail, *styptics* must be applied, such as gelatin in 5 per cent. solution, adrenalin chlorid, or some of the older preparations, like Monsel's solution. Internally, ergot, perchlorid of iron, and calcium chlorid have been recommended. The application of fresh blood from a healthy person proved successful in one instance.

CONSTITUTIONAL DISEASES

Diagnosticate diabetes mellitus.

The diagnosis of diabetes mellitus is based on the continued presence of grape-sugar or glucose in the urine. The total amount of urine is greatly increased—from 6 to 8 pints and over may be passed in twenty-four hours; the specific gravity is high—1030 or over; the color, yellow or straw; albumin may be present. The urine has a syrupy appearance. The general symptoms are abnormal appetite, intense thirst, a peculiar odor of the breath, pruritus, and a number of cutaneous complications.

Give the characteristic differences between diabetes mellitus and diabetes insipidus.

Diabetes Mellitus.	*Diabetes Insipidus.*
Specific gravity of urine nearly always high, rarely low.	Specific gravity of urine low—never exceeding 1010.
Glucose constantly present.	Glucose absent.
Abnormal hunger and thirst, itching of the skin, tendency to boils and carbuncles, characteristic ethereal odor of the breath.	General symptoms of diabetes mellitus absent.

What cutaneous diseases may occur as complications of saccharine diabetes?

Erythema, eczema, especially of the genital region; pruritus, boils, carbuncles, gangrene, xanthoma.

Describe the treatment of diabetes mellitus.

Starches and sugars must be restricted; the diet should consist chiefly of meat, fish, and green vegetables. The patient's tolerance to starches and sugars is first determined by experiment, and his diet is then regulated so as to keep the excretion of sugar in the urine at the lowest possible point; *2 per cent.* is within the limits of safety, and it is useless to attempt to eliminate the sugar altogether if the nutrition begins to suffer. Gluten and bran-bread may be substituted for ordinary white bread, and *saccharin* used instead of sugar. The patient should always be given a complete *diet-list* containing both the articles that are permitted and those which are prohibited. Medicinally, either *opium* or one of its derivatives, especially

codein, is usually given. Potassium bromid and the arsenite of bromin, 3 to 5 mm. after meals, have also been recommended. Other drugs that may be mentioned are arsenic, antipyrin, the salicylates, nitroglycerin, etc.

Differentiate pancreatitis and diabetes mellitus.

In *diabetes mellitus* the quantity of urine is increased and glucose is constantly present. In *pancreatitis* glycosuria may or may not be present, but is rarely constant, and the stools contain fat.

Give the treatment of an acute attack of gout.

Five grains of blue mass, at once followed by saline. Wine of colchicin, 10 to 20 drops, well diluted, every two hours, with one of the salts of potash or lithia. If the pain is severe, Dover's powder or morphin may be required. The affected joint should be wrapped in cotton and placed at rest. Plain water or some mineral water, as Carlsbad or Buffalo lithia water, should be taken copiously.

Give the prophylactic treatment of gout.

Dietetic.—Fish, eggs, oysters, light meats, and green vegetables are permitted; the red meats, sweet fruits, alcoholic and malt liquors, especially sweet wines and champagne, must be prohibited; starchy foods, bread, potato, and the like must be restricted. Some mineral water, such as Carlsbad, Vichy, or an equivalent American water, should be ordered.

Hygienic.—Regular exercise in the open air, avoiding exposure; a daily cool bath or shower with friction to stimulate the action of the skin.

What are the differential points between gout and arthritis deformans?

Gout.	*Arthritis Deformans.*
Predisposing factors: overindulgence in eating and drinking, etc.	Predisposing factors: feeble health, bad hygienic environment; in the female sex: frequent pregnancies, prolonged lactation.
History of acute attacks of gout in the great toe.	Rarely acute; several joints involved simultaneously, especially the joints of the hand and wrist; permanent deformity.
Urine: uric acid increased, brick-dust sediment; glycosuria frequently present.	Urine not characteristic.
Deposits of sodium urate in the joints and in the cartilages of the ear.	Permanent deformity and disability from ankylosis.

Differentiate rheumatism from gout.

Rheumatism.	*Gout.*
Onset gradual.	Onset sudden.
Involvement of several of the larger joints in succession.	Involvement of the smaller joints, especially the great toe.
Urinary findings not distinctive.	Excessive uric acid in the urine and in the blood. Deposits of sodium urate in the joints and cartilage of the ear.
Symptoms grow worse on the approach of stormy weather.	Not affected by changes in the weather.
Chronic endocarditis frequently present.	No tendency to involve endocardium.
Sweating and sometimes fever.	Sweating and fever not marked.

Define lithemia.

A morbid condition due to malassimilation of nitrogenous food, and characterized by an excess of uric acid in the urine (brick-dust sediment), vertigo, insomnia, irritability or depression, and dyspeptic symptoms.

Give the treatment of sciatica.

Internally.—The salicylates are of value when there is a rheumatic element. Phenacetin and other coal-tar products sometimes control the pain; in severe cases morphin is necessary. Putting the leg in splints may be tried. The most successful treatment is by means of deep injections of morphin, cocain, antipyrin, or even water. Counterirritation by means of blisters, acupuncture, or the actual cautery is also recommended. Inunctions with various preparations containing methyl salicylate or the natural oil of wintergreen are of value. If all other measures fail, relief may be obtained by cutting down on the nerve and stretching it.

Give the symptoms of (a) acute lead-poisoning; (b) chronic lead-poisoning.

(a) Violent *colicky pains* and *constipation;* the abdomen may be distended and tender on pressure or rigid and retracted; the pain is relieved by deep pressure. The temperature is usually subnormal. *Anemia* develops early. Sometimes nervous symptoms are more prominent: neuritis, convulsions, epilepsy, and delirium. There may be hemorrhages from the mucous membranes, and the urine contains albumin and tube-casts.

(b) *Anemia* of the secondary type; the face is sallow or of a yellowish color; the muscles are wasted. The abdomen is retracted and rigid; along the border of the gums a *blue line* is seen. The symptoms are: dyspepsia, metallic taste in the mouth, coated tongue, fetid breath, obstinate *constipation.* There may be paralysis of the extensor muscles, causing *wrist-drop* and *foot-drop;* sometimes there are pains in the joints. Arteriosclerosis and chronic interstitial nephritis are often present. In the nervous form, known as *lead encephalopathy,* there is intense headache; sometimes convulsions, delirium, coma, and blindness from atrophy of the optic nerve.

Give the causes and clinical features of purpura simplex.

Causes.—The infectious fevers, scurvy, hemophilia, pernicious anemia, splenic leukemia, Hodgkin's disease, ulcerative endocarditis, malignant sarcoma. There is also a primary form.

The *symptoms* are not marked; vague pains in the limbs and other parts of the body are sometimes complained of; some anemia is always present; the *eruption* consists of bright-red spots of variable size, not affected by pressure, and larger spots or streaks, called vibices or ecchymoses. The eruption occurs especially upon the legs, and comes on in successive crops. Sometimes large blebs filled with thin blood form under the skin and become gangrenous.

Give the characteristic symptoms of purpura hæmorrhagica.

A variable degree of fever, which may go as high as 105° F.; frequent pulse; pain in the lumbar regions and in the extremities, and great weakness

due to anemia. The characteristic eruption develops early; the *hemorrhages* take various forms—epistaxis, hematemesis, hematuria, and bleeding from various mucous membranes in the body.

What is scurvy? How should it be prevented and treated?

A constitutional condition brought about by long-continued abstinence from fresh vegetables, or in infants by artificial feeding, and characterized by great weakness, anemia, swollen and spongy gums, a tendency to purpura and subcutaneous and submucous hemorrhages. A diet of fresh vegetables is an absolute preventive; lemon-juice should also be administered.

Treatment.—Mouth-washes and chlorate of potassium or nitrate of silver applications to the bleeding gums; iron; fresh vegetables, and lemonade. In *infantile scurvy* excellent results are obtained by placing the child on a modified milk mixture and administering orange-juice.

Describe the treatment of rachitis.

Proper *hygiene;* plenty of fresh air and sunshine, but not too much exercise; daily bathing; nutritious diet. *Medicinally:* cod-liver oil, iron in the form of the syrup of the iodid, and phosphorus are indicated. The latter may be given in the form of calcium lactophosphate (1 dr.) or the elixir of phosphorus (5 to 10 drops).

What are the causes of rachitis?

Bad hygiene, want of sunlight and improper air, improper food, artificial feeding, the use of patent infant's food rich in starches and deficient in animal proteids, prolonged lactation, and nursing the child during pregnancy.

How would you diagnose a case of rickets?

The disease usually develops between the first and second years; the child becomes irritable, restless at night, and slightly feverish, with profuse perspiration about the head and neck. Dentition is usually delayed; the head is large in proportion to the body, and square in outline; the external ends of the ribs are enlarged, forming the *rachitic rosary;* the chest is curved at the level of the ensiform cartilage (Harrison's curve); spinal curvatures are observed; the long bones are curved, and the articular extremities enlarged. The fontanels close later than in healthy children.

What are the four characteristic symptoms of exophthalmic goiter? Give the supposed etiology.

(1) Thyroid enlargement; (2) exophthalmos with Stellwag's and von Graefe's signs; (3) tachycardia; and (4) tremors.

The condition is supposed to be due to excessive functional activity of the thyroid gland—hyperthyroidism. According to another theory, it is due to a central lesion in the medulla oblongata.

Give the treatment of exophthalmic goiter.

The treatment is purely symptomatic and palliative; *hydrotherapeutic* measures are useful. If the symptoms are marked, rest in bed with ice-bag to the precordia may be necessary.

Thyroid extract is counterindicated in most cases, but sometimes appears to do good; these are the cases in which the symptoms of hyperthyroidism are not marked, and which somewhat resemble a mild condition of myxedema. *Antithyroidin,* a preparation of serum from thyroidectomized sheep, is recommended in cases of true hyperthyroidism; the dose is 15 to 30 minims three times a day. *Thymus gland,* 2 to 5 gr. three times a day, and *suprarenal extract* are also recommended. *Beebe's serum,* obtained from the blood of animals inoculated with human thyroid glands, is said to have proved successful in some cases. In the opinion of some, excision of half the gland is indicated.

Define myxedema and give its treatment.

A condition due to loss of function of the thyroid gland, and characterized by a myxedematous condition of the subcutaneous tissues, mental failure, and atrophy or pathologic change of the thyroid gland.

The *treatment* of myxedema consists in the administration of *thyroid extract,* at first in large ascending doses, beginning with 2 gr. three times a day, and increasing the dose until the patient takes from 10 to 15 gr. in twenty-four hours. The size of the dose is regulated by the effect produced and the occurrence of symptoms of thyroidism (rapid pulse; nervous excitability). After recovery has taken place, the patient must persevere for the rest of his life in the use of the drug in doses sufficient to preserve normal metabolism.

Define Hodgkin's disease and outline its treatment.

Hodgkin's disease, or pseudoleukemia, is characterized by hyperplasia of the lymph-glands and anemia, without an excess of leukocytes. The treatment is the same as that of pernicious anemia (see page 406).

Differentiate heat exhaustion from sunstroke.

The principal difference is in the temperature, which is normal or even subnormal in heat-exhaustion, and excessively high in sunstroke or *thermic fever*—105° to 108° F. in ordinary cases, and sometimes as high as 112° or 115° F. There is marked dyspnea, and sometimes Cheyne-Stokes breathing; the pupils are at first dilated and later contracted; the pulse is very rapid; consciousness is lost, and convulsions may be present. *Heat-exhaustion* is usually preceded by premonitory symptoms, such as dizziness, headache, nausea, and vomiting. The symptoms are much less marked; painful muscular spasms are often observed.

How should insolation be treated?

With a cold bath to combat the temperature, and heart stimulants—strychnin, digitalis, and alcohol. Instead of the full cold bath, a cold pack, an ice-rub, or affusion may be substituted. Ice-water enemas have also been recommended. The cold application is continued until the temperature comes down to normal.

Differentiate between sunstroke and apoplexy.

The diagnosis must be based on the history, the temperature, which is much higher in *sunstroke*, and on the presence or absence of signs of hemiplegia. In *apoplexy* there are hemiplegia, deviation of the eyes, and sometimes of the head, irregularity of the pupils, and flapping of the cheek on one side or the other during respiration. The temperature is never so high as in sunstroke, and the pulse is full and bounding.

What causes contribute to obesity? What tissues are most frequently invaded in obesity?

Overeating, especially of starchy foods; lack of proper exercise; excessive indulgence in alcohol, and particularly malt liquors, such as beer. The fat is deposited chiefly in the subcutaneous tissues, particularly in the abdominal wall, in the omentum, and sometimes in the myocardium.

NERVOUS DISEASES

Give the more common causes of chorea.

Rheumatism, endocarditis, scarlet fever, fright, overexertion at school, imitation. It is more common in childhood and in the female sex; a family tendency has been noted.

Give diagnosis and treatment of chorea.

Disorderly, so-called choreic movements, either confined to one member or affecting the entire body, are the most conspicuous symptoms. The child is awkward at table and in dressing itself, especially in buttoning its clothes; the gait may be jerky and stumbling; the involvement of the larynx causes stammering and uncouth, involuntary cries; spasm of the muscles of deglutition may interfere with swallowing. The movements grow worse when attention is directed to them, but diminish during repose and cease altogether during sleep. A murmur, either organic and depending on endocarditis, or hemic from the associated anemia, is present. The diagnosis is rarely difficult. *Disseminated spinal sclerosis* is distinguished by nystagmus, scanning speech, an arrhythmic intention tremor.

Treatment.—Complete rest and isolation from other members of the family and other children. In severe cases the treatment is best carried on in a hospital, but the child should have plenty of fresh air when the weather is fine. Moral control is most important. The drugs recommended for chorea are arsenic in the form of Fowler's solution, in ascending doses up to 8 or 10 drops three times a day; cimicifuga; quinin. Later, graduated exercises are advisable.

What age and sex are most subject to chorea?

Childhood between the fifth and fifteenth years; female sex.

What is the diagnostic significance of Cheyne-Stokes respiration?

It occurs in apoplexy, meningitis, brain tumor, uremic coma, some forms of opium-poisoning, sunstroke, and advanced cardiac disease with fatty degeneration.

Describe the treatment of paralysis agitans.

Nutritious diet; rest of body and mind; bathing, followed by friction of the skin; massage; electricity; general tonics, such as iron, arsenic, and phosphorus. For the tremors, bromid of potassium, hyoscin, and hyoscyamin are recommended.

What are the general symptoms in encephalic tumors?

Headache, vomiting, optic neuritis, increased blood-pressure.

Describe aphasia.

Inability to utter words, to comprehend them, or to write them.

Sensory Aphasia.—*Word-blindness*, inability to recognize written or printed words; *word-deafness*, inability to interpret spoken words.

Motor Aphasia.—Inability to utter words, although knowing their meaning.

Paraphasia.—The misuse of words or syllables.

Motor Agraphia.—Inability to write words, owing to lack of co-ordination.

Aphasia occurs in any injury to the brain, hemorrhage, thrombosis, embolism, abscess, tumor involving the center of speech or Broca's region.

What are the causes and symptoms of abscess of the brain?

Causes.—Traumatism, mastoid disease following otitis media, abscess elsewhere in the body, as in the lungs or liver; ulcerative endocarditis; the infectious fevers.

The *course* may be acute, with high fever, rigors, headache, delirium, convulsions, vomiting, and coma. The general *symptoms* in chronic cases are headache, mental impairment, vertigo, vomiting, irregular fever, stupor, loss of flesh and strength. The focal phenomena vary with the site of the abscess.

What parts of the brain are most liable to hemorrhage?

The parts supplied by the middle cerebral artery.

What conditions predispose to cerebral hemorrhage?

Heredity, middle life, arteriosclerosis, and conditions which produce it, as rheumatism, gout, syphilis, alcoholism, chronic Bright's disease, and hypertrophy of the heart. It sometimes occurs in young children.

Describe the symptoms of a case of apoplexy due to cerebral hemorrhage.

Prodromal.—Headache, vertigo, tinnitus, weakness or numbness on the affected side, sometimes vomiting.

Symptoms of the Attack.—Sudden unconsciousness without warning; the face is flushed, the lips blue, the breathing stertorous, the pulse full and slow, the temperature at first subnormal, then elevated. Evidences of paralysis are present; the head and eyes may be rotated toward the side of the lesion; the pupils are irregular; one cheek flaps in respiration; the affected arm, when raised and allowed to fall, drops 'dead'; there is a difference of temperature between the two axillæ. In grave cases the patient may die during the attack. Death may also occur during the coma.

Differentiate the coma of opium-poisoning from that of cerebral hemorrhage.

In opium-poisoning coma develops more gradually and the pupils are contracted to pin-point; the breathing is slow and shallow. Age, history of the case, condition of the arteries, the evidence of paralysis, and the difference of temperature in the two axillæ may assist in the diagnosis.

How should apoplexy due to cerebral hemorrhage be treated?

Raise the head and shoulders and apply an ice-bag to the head. Croton oil, 1 to 3 drops, should be placed on the back of the tongue. If the pulse is strong, *venesection* is indicated; but if the face is pale and the pulse feeble, *stimulants*, such as ammonium and strychnin, must be administered. The subsequent treatment consists in the administration of iodid of potassium and strychnin, and later electricity, massage, and passive movements.

What are the symptoms of delirium tremens?

Anorexia, restlessness, insomnia, tremors of the lips, tongue, and limbs, terrifying visual and auditory hallucinations. The skin is moist, the face anxious, the pupils dilated, the temperature slightly elevated, the pulse soft and rapid.

Give the treatment of delirium tremens.

Careful feeding with easily digested food, such as beef-tea and milk. No alcohol unless the pulse is very feeble. To induce sleep chloral, 20 gr.; bromid of potassium, $\frac{1}{2}$ to 1 dr.; hyoscin hydrobromid, $\frac{1}{100}$ to $\frac{1}{50}$ gr.; morphin, $\frac{1}{4}$ gr.; paraldehyd, 1 dr., may be given. When the stomach is not retentive, both food and medicines must be given per rectum. Strychnin is usually indicated by the condition of the pulse.

Distinguish between the terms illusion, delusion, and hallucination as used in diagnosis.

Illusion is a perverted perception of an actual object; thus the patient transforms ordinary articles into snakes, rats, etc.

A *delusion* is a faulty belief concerning a subject capable of physical demonstration.

Hallucination is a false perception which is entirely subjective. One who hears voices and sees objects when none exist is the subject of hallucinations.

Give the symptomatology of epilepsy.

Grand Mal.—The patient cries out and falls to the floor unconscious. The body is thrown into a tonic spasm, in which the head is retracted, the limbs extended, and the hands firmly clenched. This is followed by clonic intermittent movements; the face becomes cyanotic, the pupils dilated, and the patient foams at the mouth. The seizure is often preceded by a warning, termed an *aura*, which may assume various forms. The convulsion is followed by coma and sometimes by sleep. During the attack the patient bites his tongue and the urine is often voided unconsciously.

Petit Mal.—A seizure consisting of a momentary unconsciousness, lasting a few seconds, with twitching of the muscles.

Differentiate epilepsy from hysteria.

In *epilepsy* there is complete loss of consciousness; the convulsions are at first tonic and then clonic; the pupils are dilated during the attack; the patient often bites his tongue. The attack may be ushered in by an aura.

In *hysteria* the loss of consciousness is never complete—the patient is conscious of her surroundings; the convulsions are not characteristic; the pupils are irregular; areas of anesthesia can be detected. The patient, who is usually a woman between the ages of fifteen and twenty-five, never hurts herself in falling.

Give the treatment of epilepsy.

The diet is the most important factor; it should be largely vegetable, with a *minimum of salt*, and all highly seasoned food and stimulants must be prohibited. Mental and physical excitement must be avoided. A mixture of equal parts of sodium, potassium, and ammonium *bromid*, from 1 to 2 dr. a day, is the most reliable remedy. One or two drops of *Fowler's solution* are given with the bromids to prevent acne, and a few grains of *antipyrin* may be added. Inhalation of amyl nitrite, taken as soon as the aura gives warning of an attack, sometimes aborts it. During the attack itself no special treatment is required.

Define catalepsy and give its etiology.

A condition in which the limbs are plastic and remain in any position in which they are placed. It occurs in hysteria, hypnotism, epilepsy, some organic diseases of the brain, and certain forms of insanity.

What are the causes, symptoms, and prognosis of Bell's palsy?

Causes.—(1) Lesion of the facial center in the cortex or the nucleus of the facial nerve—tumor, clot, or abscess. (2) Paralysis of the facial nerve in the petrous portion of the temporal bone from fracture or extension of inflammation of the middle ear. (3) Inflammation of the peripheral filaments of the nerve from exposure to cold, injury, rheumatism, or one of the infectious fevers.

Symptoms.—The condition is readily recognized; the affected side is smooth and expressionless; the angle of the mouth droops; the eye cannot be closed; tears flow over the cheek, and the speech is affected on account of the inability to control the lips. When the lesion is central, the upper part of the face escapes and other cranial nerves are involved. When the lesion is in the Fallopian canal, there may be loss of taste in the anterior part of the tongue, and deafness or hyperacousia. When the peripheral filaments are affected, the paresis is complete and reactions of degeneration are present.

The *prognosis* depends on the cause; it is regarded as favorable when the palsy is due to peripheral neuritis. If the palsy is central, the prognosis is grave, except in syphilitic cases.

Describe the symptoms and treatment of chronic hydrocephalus in children.

Symptoms.—The disease may be present at birth, and the large head interfere with delivery. The head is globular; the fontanels and sutures

remain open, and the face is relatively small; the eyes protrude and are rotated downward. The weight of the head interferes with the child's movements. The intellect is impaired; exceptionally there may be precociousness. The reflexes are exaggerated; spastic paralysis may be present, and convulsions sometimes develop.

Treatment.—Medical treatment is unsatisfactory; if the pressure symptoms are marked, temporary relief is obtained by tapping, followed by compression of the skull with bands of adhesive plaster.

Differentiate tonic and clonic spasms.

Continued contractions are termed *tonic;* intermittent, *clonic.*

What is the significance of the patellar reflex as a sign of disease?

The knee-jerk is *increased* in organic disease of the brain; lesions of the cord above the lumbar enlargement; disseminated cerebrospinal sclerosis and lateral sclerosis; in mania, hysteria, strychnin-poisoning, and spinal meningitis. The reflex is *diminished* or *absent* in posterior sclerosis; poliomyelitis (the anterior horns are part of the reflex center); myelitis; poisoning from drugs which destroy the cord, as antimony and chloral; degeneration of the muscle, as pseudomuscular hypertrophy and neuritis.

What is the most common cause of tabes dorsalis?

Syphilis.

Define Argyll-Robertson pupil and name the disease in which it is one of the diagnostic symptoms.

A pupil which fails to respond to light, but accommodates for distance. Tabes dorsalis.

Give the symptoms and treatment of locomotor ataxia.

Symptoms.—Loss of co-ordination; inability to stand with the eyes closed and feet close together (Romberg's sign); the arms may be affected; the patient is unable to touch the tip of his nose with his eyes closed; characteristic gait; no loss of power; sharp, lancinating pains appearing in paroxysms, especially around the body—so-called 'girdle pains'; pain in the stomach, with vomiting—so-called 'gastric crises'—also occur. Paresthesia is observed in various parts of the body. The knee-jerk is lost, and the Argyll-Robertson pupil is present. There may be diplopia, dimness of vision from optic atrophy, and paresis of the ocular muscles. As the disease progresses, sexual power is lost; the patient develops epileptiform seizures and ultimately dementia.

The most important part of the *treatment* consists in graduated exercises for the training of the power of co-ordination, after Fränkel, and hydrotherapy. If there is a suspicion of syphilis, potassium iodid should be given. In any case iodid of potassium, mercury, and arsenic are the most reliable remedies.

Give the symptoms of acute myelitis.

The disease begins like an infection, with moderate fever, coated tongue, constipation, and pain in the back and limbs. Girdle pain may be present at the level of the disease, with numbness, tingling, burning, etc. Paralysis and loss of sensation below the level of the lesion and sphincter paralysis are the important symptoms. The paralysis is flaccid. The reflexes are increased when the lesion is above the lumbar enlargement; absent when the latter is involved.

Make a diagnosis of infantile spinal paralysis.

The onset is sudden, with chill, convulsions, delirium, and fever (103° F.); the paralysis comes on at once and may be extensive or confined to certain groups of muscles, particularly in the lower extremities. The distribution is irregular. There is a tendency to spontaneous improvement. Sensation is not affected, and the bladder and rectum are not involved. The muscles yield the reactions of degeneration; from contractures of atrophied muscles deformities develop.

Relate the history of a case of progressive muscular atrophy.

Pain, coldness, or numbness; loss of power and atrophy beginning in the small muscles of the hand, first of one and later of both. The paralysis next involves the muscles of the shoulders and arms, which slowly waste, and so the patient is gradually reduced to a skeleton. The hands are characteristic—'*main en griffe.*' Reactions of degeneration develop late; sensation is not impaired, except for subjective coldness and numbness. Death may result from an intercurrent disease or from extension of the paralysis to the medulla and bulbar palsy. The sphincters are not involved.

Define Landry's paralysis. Give symptomatology, prognosis, and treatment.

An acute disease of rare occurrence characterized by motor paralysis beginning in the feet and rapidly spreading upward until it involves the muscles of respiration and deglutition.

Symptoms.—Onset with fever. Paralysis beginning in the legs and successively involving the trunk, upper extremities, and muscles of respiration and deglutition; the reflexes are abolished; the sphincters are unaffected; sensation is normal, except for paresthesia; the muscles are flexed, but there is no wasting and reactions of degeneration are wanting. The spleen and lymphatic glands may be swollen.

The *prognosis* is practically always unfavorable; a few cases recover spontaneously.

Treatment.—Counterirritation to the spine in the form of cups and electricity to the affected muscles are recommended.

Describe the symptoms and treatment of multiple sclerosis.

The *symptoms* may resemble either those of locomotor ataxia or those of lateral sclerosis, depending on the part of the cord chiefly affected. The characteristic symptoms are spastic paraplegia with exaggerated reflexes, vague pains, a coarse tremor developing on movement, slow wasting, 'scanning' speech, nystagmus, sometimes diplopia, and sometimes paraly-

sis of the ocular muscles; mental impairment. As a rule, there are no sensory or trophic disturbances; the sphincters are not affected.

The *treatment* is the same as that of posterior sclerosis. The salts of gold, silver, and arsenic have been tried. For the tremors the bromids, hyoscin, hyoscyamin, and belladonna are recommended.

How does paralysis of the third nerve affect the eye?

There may be ptosis, slight exophthalmos, external strabismus, diplopia, and a dilated pupil which reacts neither to accommodation nor to light.

Give the symptoms resulting from paralysis of the phrenic nerve.

The condition is known as *phrenic dyspnea.* It is brought on by the slightest exertion; the patient experiences a sense of suffocation. Other acts, such as sighing, straining at stool, phonation, coughing, and sneezing, are interfered with. The thoracic movements are reversed—the epigastrium and hypochondriac regions are drawn in during inspiration and pushed out during expiration. If the paralysis is unilateral, the corresponding hypochondriac region is retracted.

Give the treatment of tic douloureux.

During the attack local applications, hot cloths, a small blister, or a hypodermic injection of cocain, chloroform, morphin, or atropin. Internally, one of the following remedies should be given: antipyrin, phenacetin, cannabis indica, bromid of potassium. Morphin should not be given because of the danger of inducing the habit.

During the interval a possible exciting cause should be searched for and, if found, removed or treated. The various underlying conditions must receive appropriate treatment, as iron and arsenic in anemia, potassium iodid in lead-poisoning. In obstinate cases surgical interference may be required. The operations are nerve-stretching, dissection of the nerve, and removal of a portion of the nerve or the Gasserian ganglion.

Differentiate neuritis from neuralgia.

Neuritis.	*Neuralgia.*
Pain continuous.	Pain paroxysmal.
Tenderness along the nerve.	Absent.
Paresthesia, anesthesia, paresis, and wasting.	Absent.
Reactions of degeneration.	Absent.
Herpes not present.	Sometimes accompanied by herpes.

Describe herpes zoster and its treatment.

Groups of vesicles on inflammatory bases appear along the course of the intercostal nerves, rarely in the lumbar and sacral regions. The distribution is unilateral, the eruption extending slightly beyond the middle line. The fluid in the vesicles soon becomes turbid, dries up, and forms a crust, which goes away in a few days. *Neuralgia* usually precedes and accompanies the eruption, but may be absent altogether.

Treatment.—The blisters should be protected with a dressing of ichthyol and flexible collodion, or a gelatin paste, medicated, if desired, with morphin,

menthol, or carbolic acid, to relieve the pain. Phosphid of zinc in the dose of $\frac{1}{4}$ gr. every three hours is warmly recommended. Phenacetin, antipyrin, and sodium salicylate have been recommended for the pain; sometimes morphin is required.

Give the etiology of multiple neuritis.

Alcoholism; exposure to cold and wet; poisoning with lead, arsenic, and other minerals, and with the poisons of syphilis and malaria; rheumatism and the infectious fevers.

Give the symptoms and treatment of migraine.

Symptoms.—The headache is sharp and stabbing and limited to one side; there is great hyperesthesia to light and sound; nausea and vomiting are frequently present. Other symptoms are: vertigo, spasm of the facial muscles, tingling or numbness in one hand, partial aphasia, hallucinations of sight, and paresis of the ocular muscles.

Treatment.—The patient should remain in a dark, quiet room during the attack. The following remedies are recommended: antipyrin, caffein, potassium bromid, salol, or, finally, morphin and atropin. During the intervals arsenic, potassium iodid, potassium bromid, valerate of zinc, and cannabis indica, especially the latter, in the dose of $\frac{1}{4}$ to $\frac{1}{2}$ gr., are recommended.

Describe the treatment of neurasthenia.

The most hopeful methods of treatment are hydrotherapy, massage, particularly of the back, and a fresh-air cure. The *rest cure* is successful in some cases. Careful attention must be given to the diet, bathing, clothing, *daily occupation*, and systematic exercise. The medicinal treatment is purely symptomatic. The anemic cases require iron, etc. Tincture of nux vomica in large doses proves useful in many cases.

Describe the treatment of hay-fever.

In some cases there is some individual trouble which, if found, must receive suitable treatment. Most patients have to leave their homes to escape the annual attack. A sea-voyage or sojourn at some mountain resort—in the White Mountains, Adirondacks, Catskills, or Alleghenies—may be advised. A great number of remedies are recommended. Among the latest, the most valuable are *suprarenal extract*, both locally and internally, and *pollantin.* Belladonna, quinin, arsenic, and strychnin are recommended as general tonics; local applications of cocain, menthol, etc., are well spoken of.

SURGERY

CONGESTION AND INFLAMMATION

Describe active congestion; passive congestion. State their points of difference.

Active congestion is an increase in the amount of blood in the arteries of a part, with an increase in the velocity of the blood-stream. The part is reddened, not perceptibly enlarged, and the velocity of the blood-current, the temperature, and the functional activity of the part are *increased.*

Passive congestion is an increase in the amount of blood in the veins and capillaries of a part, with diminished velocity of the blood-stream. The part is bluish, greatly swollen, and the velocity of the blood-current, the temperature, and the functional activity of the part are *diminished.*

What is inflammation? How does inflammation extend and how may it terminate?

Inflammation is the succession of changes which occur in living tissue when it is injured, providing the injury is not of such a degree as to destroy the structure and vitality of the tissues at once. The cardinal symptoms of inflammation are pain, heat, redness, swelling, and impaired function (see also Section on Pathology). Inflammation may extend by continuity, by contiguity, through the blood, or through the lymphatics. Inflammation may terminate by resolution, suppuration, ulceration, or gangrene.

Give the etiology of inflammation.

Predisposing causes are those which impair the general vigor, injure the blood, weaken the tissues, or impair the nutrition. Among these causes are shock, hemorrhage, gout, rheumatism, diabetes, Bright's disease, alcoholism, and syphilis.

Exciting causes are *mechanical*, *chemical* (stings of insects, ivy poisoning, etc.), *thermal* (heat and cold), and *bacterial* (micro-organism causing erysipelas).

What is the difference between congestion and inflammation?

Congestion is an excess of blood in the blood-vessels of a part. The part is reddened, the temperature is increased, swelling is scarcely appreciable, pain is not present except that the patient may complain of a throbbing sensation, and the function and nutrition of the part are increased. *Inflammation* is the result of injury (see preceding question). The part is reddened, the temperature is also increased, the swelling is usually considerable, and pain is present, depending upon the character of the tissue involved, the severity of the injury, and the reaction of the tissues. The function of the part is diminished, and fever is usually present.

What is an abscess?

An abscess is a circumscribed collection of pus surrounded by a wall of lymph.

Define acute and chronic abscess.

An *acute* abscess is a circumscribed collection of pus which develops with all the signs and symptoms of inflammation. A *chronic* abscess is one which forms without the signs and symptoms of inflammation, and is usually tuberculous.

How does a carbuncle differ from a furuncle?

A carbuncle is a localized inflammation of the skin and subcutaneous tissue with necrosis, involving a much larger surface than a furuncle, and attended by the formation of sloughs of a considerable size. It differs from a boil in being much larger, flattened instead of conical, and accompanied by extensive edema of the surrounding tissues. The skin gives way in several places, and large sloughs are discharged. The *causes* of carbuncle are certain constitutional diseases and deep infection. Furuncles result from infection of the gland-ducts or hair-follicles of the skin.

What are the symptoms of septic surgical fever?

The condition is ushered in, from thirty-six to forty-eight hours after an operation or injury, by chilly sensations and general discomfort. The *temperature* rises sharply and is characterized by evening exacerbations and morning remissions, reaching its greatest height about the third or fourth day, when suppuration sets in. The temperature, which may reach 104° F. or more, begins to drop as soon as free exit for the pus is established, and becomes normal in a few days. The patient exhibits the general phenomena of *fever:* thirst, anorexia, nausea, dry and coated tongue, constipation, headache, and pain in the back and legs. The *urine* is scanty and high colored. Examination of the blood usually shows a decided *leukocytosis.* The wound is painful, tender, swollen, and later contains pus.

Define septicemia and give its causes.

A septic intoxication caused by the absorption of the products of putrefaction or by the entrance of bacteria into the blood. *Symptoms:* Irregular temperature, ranging from 100° to 105° F.; weak and very rapid pulse; frequent chills; severe headache; nausea; often vomiting and diarrhea.

What is the differential diagnosis between septicemia and pyemia?

Pyemia is septicemia plus metastatic abscesses. The diagnosis of pyemia is based on the presence of symptoms of abscesses.

Make a differential diagnosis of coma from injury, apoplexy, uremia, opium-poisoning, and alcoholic intoxication.

Examine carefully for any evidence of *traumatism* and for the odor of *alcohol* or *opium* on the breath. Catheterize the patient and examine the urine for albumin and sugar, and determine the specific gravity (low in

uremia). In doubtful cases of coma use the ophthalmoscope. In *apoplexy* hemiplegia exists, and the initial temperature is for a short time subnormal. A single convulsion may have ushered in the attack. Hemorrhage into the pons causes extreme contraction of the pupils (pin-point pupils) and, usually, crossed paralysis, with sweating and high temperature. In *uremia*, in addition to the urinary findings, there is persistent subnormal temperature, convulsions are prone to occur, and there may be edema of the legs. The odor of breath is urinous and the tongue is dry and fissured. Paralysis and stertor are absent. In *opium-poisoning* the pupils are contracted to pin-point, the respirations are usually slow, shallow, and quiet, and there is no paralysis. In *alcoholism* the patient can usually be aroused; the temperature is subnormal, and the breathing stertorous; the pupils are equal; no paralysis exists.

In coma from *concussion* the patient can usually be roused, but he will resist all attempts to open the eyes or mouth or to move the limbs. In a severe case the patients lie there with complete muscular relaxation; cold extremities; shallow and quiet respirations; and frequent, small, soft and irregular pulse. In *compression* the skin is hot and moist; the respirations are slow and stertorous; the cheeks flap during expiration; the pulse is slow, full, and may be irregular; the pupils are somewhat dilated and do not react readily to light. In *unilateral compression* the pupil on the side of the compression is apt to be much dilated. In *cerebral compression* there is usually retention of urine, and often incontinence of feces. There is paralysis, which may be very limited (monoplegia or hemiplegia).

In bleeding from the middle meningeal artery a period of consciousness intervenes between the injury and the coma. In compression from depressed fracture or from a foreign body the symptoms usually come on at once.

Differentiate between the following forms of inflammation: serous, serofibrinous, and serohemorrhagic.

In *serous* inflammation there is an exudation of fluid with comparatively little cellular matter. In *serofibrinous* inflammation the exudate contains more fibrin, and shows a marked tendency to clot. In *serohemorrhagic* inflammation the exudate contains large numbers of red blood-corpuscles.

Define peritonitis. State three ways in which the peritoneum may be invaded by bacteria.

By peritonitis is meant an inflammation of the peritoneum.

Bacteria may reach the peritoneal cavity—(1) By means of an abdominal wound or the entrance of a foreign body; (2) by extravasations from the stomach, intestines, gall-bladder, urinary bladder, Fallopian tube, uterus, or by the passage of micro-organisms through the damaged walls of any of these viscera; (3) by way of an open Fallopian tube, rupture of an abscess of the pancreas, spleen, or liver.

What is lupus?

Lupus vulgaris is a chronic inflammatory disease of the skin and mucous membranes due to the tubercle bacillus, and characterized by the formation of nodules of granulation tissue. Frequently these nodules ulcerate.

Give the etiology and treatment of noma.

The disease is most frequently encountered in children recovering from an acute infectious disease. It is seen after scarlatina, typhoid, pneumonia, dysentery, and especially after measles. The disease is supposed to be caused by pyogenic organisms.

Treatment.—Administer an anesthetic and destroy the gangrenous area with the Paquelin cautery. Have the area washed every few hours with dioxid of hydrogen, irrigate with hot salt solution or boric-acid solution, and dress with compresses soaked in one of the above solutions. Nourishing food should be given at frequent intervals, and whisky, strychnin, and iron in large doses.

Give the etiology, varieties, and symptoms of erysipelas.

Etiology.—Infection with the *Streptococcus erysipelatis.*

Varieties.—Cutaneous, cellulo-cutaneous (phlegmonous), cellular (cellulitis), and mucous.

Symptoms.—*Cutaneous erysipelas* most frequently attacks the face. The temperature rises rapidly, reaching 103° to 104° F., is remittent in type, and usually falls in four or five days by crisis. At the time of febrile onset spots of redness appear on the skin. These spots run together and soon form a large, dark red, and slightly swollen area, with sharply defined and slightly elevated border. The sharp definition from the healthy skin is a characteristic sign. The erysipelatous area gradually spreads, while the color fades at the original disease focus. The redness disappears on pressure and returns at once when pressure is removed. In the hyperemic area vesicles form, containing first serum and later, it may be, seropus. The edema of the subcutaneous tissues produces great swelling in regions where there is much loose cellular tissue. The anatomically related lymphatic glands may become large and tender. When the disease ceases to spread, the swelling and redness gradually abate, and desquamation takes place, the blebs becoming dry and crusted. *Cellulo-cutaneous erysipelas* is characterized by high temperature, the rapid onset of grave prostration, irregular chills, sweats, and very frequently delirium. The swelling is brawny, develops early, and increases with exceeding rapidity. In most cases suppuration occurs, and when this happens the parts become boggy. After evacuation of the pus sloughs form, which gradually separate and are cast off. The wound heals slowly by granulation.

Define malignant pustule and give treatment.

Malignant pustule, or woolsorters' disease, is a local lesion produced by infection with *Bacillus anthracis.* It differs from ordinary carbuncle in the following respects: the presence of a central, depressed, blackish slough; absence of localized pain; absence of suppuration (unless mixed infection is present); and greater severity of the constitutional symptoms.

Treatment.—Patient should be isolated. Immediate, complete excision of the pustule. The incisions should be carried wide of the disease, and the resulting wound carefully swabbed out with pure carbolic acid. When excisions cannot be performed, make crucial incisions through the lesion, swab the wound with pure carbolic acid, and inject about and in the pustules a 10 per cent. solution of carbolic acid every six hours until the disease

abates or toxic symptoms appear. After excision or crucial incisions apply a wet bichlorid of mercury dressing, which should be kept continually moist. *Constitutional Treatment.*—Whisky and stimulants.

Give the treatment for rattlesnake bite.

In general, the rules are to twist several fillets at different levels above the bite, to excise the bitten area, to suck or cup the wound, if possible, and to cauterize with a pure acid or heat. The fillets are not to be removed suddenly, the highest constricting band being loosened first. If no symptoms appear after a short time, remove the next, and so on. If symptoms appear, reapply the fillet. The *constitutional treatment* consists in the administration of *antivenene serum*, 10 cc. to 20 cc. hypodermically, repeated, if necessary, in three or four hours; large doses of strychnin, also given hypodermically, and very large doses of whisky by the mouth, with as much nourishing food as the patient can be induced to take.

What is hydrophobia and how is it treated?

Hydrophobia is a spasmodic and paralytic disease due to infection through a wound with the virus from a rabid animal.

Treatment.—When a person is bitten by a supposedly rabid animal and is seen soon after the injury, the wound should be excised and the part soaked in permanganate of potassium (1:4000). If the patient is not seen for a number of hours or days after the injury, local treatment is useless.

Constitutional Treatment.—Send the patient at once to a Pasteur institute for inoculations of the serum, or have the serum treatment given at home. If the patient has developed the disease, give the following treatment: free use of morphin, chloral, and chloroform. The patient is kept in a darkened room, and all external sources of irritation are removed. Nutritive enemata may be necessary.

DISEASES OF BLOOD-VESSELS

Differentiate between true and false sacculated aneurysm.

The sac of a true sacculated aneurysm contains all the coats of the artery. In a false sacculated aneurysm one or more of the coats of the artery are absent.

Describe a dissecting aneurysm.

A dissecting aneurysm is one in which the blood breaks through the intima and burrows its way between the coats of the artery; the sac of the aneurysm is formed within the wall of the vessel.

What are the varieties of arterio-venous aneurysm? State the points of difference.

An arterio-venous aneurysm is either an aneurysmal varix or a varicose aneurysm. An *aneurysmal varix* is a direct communication between an artery and a vein, without the interposition of a sac. A *varicose aneurysm* is an indirect communication between an artery and a vein with the interposition of a sac.

With what conditions may aneurysm be confounded?

Abscesses, tumors, or cysts situated over a vessel; a large growth under a vessel; pulsating bone tumors.

Define the terms thrombus, phlebitis, and varix, and give the causes of each.

A *thrombus* is a blood-clot formed within the heart or blood-vessels. It is due to alterations in the blood-current, changes in the vessel-walls, and alterations in the blood itself.

Phlebitis is inflammation of a vein. It may be due to injury of the coats of the vein, to the formation of a thrombus within the vein, to extension of inflammation from surrounding tissues, or to infection with pyogenic organisms.

Varix denotes dilatation, elongation, and more or less tortuosity of a vein. It is due to increased tension within the veins, caused by pressure from without, obstruction or occlusion of the deeper veins, or habitual over-exertion. Inherited weakness and relaxation of the system from sedentary habits are predisposing causes.

What are the most approved operative procedures in the treatment of varicose veins of the lower extremity?

Trendelenburg's Operation.—Excise a portion of the internal saphenous vein, 4 in. long, at the junction of the middle and lower thirds of the thigh. *Fergusson's Operation.*—Tie the saphenous vein at the saphenous opening and remove a section of it. A semilunar incision is made in the leg down to the deep fascia, the flap is dissected up, the vessels tied, and the flap sutured in place. *Schede's Operation.*—A circular incision is carried completely around the leg at the junction of the upper and middle thirds, the incision reaching to the deep fascia; all bleeding points are ligated, and the edges of the incision are sutured together.

Give the symptoms, diagnosis, and treatment of phlebitis.

Symptoms.—The vessel affected becomes swollen, hard, and painful. The overlying tissues are dusky and congested, and there may be some edema in the area drained by the vein. The part is hot to the touch, and the patient has fever. If suppuration occurs, the symptoms are those of a localized abscess.

Diagnosis.—In *lymphangitis* the redness is brighter and more localized, enlarged and painful glands are present, there is no cord-like vein, and the swelling is much less marked. In *erysipelas* the redness is characterized by an abrupt, raised margin; there is high fever, and the constitutional symptoms are marked.

Treatment.—Absolute rest in bed, with elevation of the affected extremity. The inflamed area should be covered with 20 per cent. ichthyol ointment, and the limb incased in cotton and lightly bandaged to a splint. When the inflammatory symptoms have subsided and the clot has had time to become organized or absorbed, massage of the part should be begun. If an abscess forms, it must be opened. In septic phlebitis, if seen early, the vein should be exposed, ligated, the infected clot turned out, and the wound packed with gauze.

Give the symptoms and treatment of nevus.

Capillary nevus occurs in the form of a slightly elevated mass, which varies in color from purple to bright red, according to the relative quantity of contained venous or arterial blood. These growths are congenital or occur soon after birth. They may be multiple, rarely exceed 1 or 2 in. in diameter, and are usually situated upon the neck or face. They may disappear, persist unchanged, or rapidly increase in size.

Treatment.—Ligation, excision, electrolysis, the cautery, and coagulating injections.

DISEASES OF MUSCLES

What are the principal affections of muscles?

Contusion, sprain, rupture of the sheath, rupture of muscle or tendon, myositis (traumatic, rheumatic, acute suppurative, tuberculous, syphilitic, parasitic, and *myositis ossificans*), atrophy, primary tumors (angioma, fibroma, chondroma, myxoma, and sarcoma), and secondary tumors (carcinoma and sarcoma).

What is the most common seat of rupture of the quadriceps extensor femoris? Give the symptoms and treatment.

Just above its insertion into the patella. *Symptoms.*—Pain just above the patella following sudden muscular exertion, with inability to extend the leg. On local examination a gap is felt, about one finger's breadth wide, extending across the thigh between the ruptured ends. *Treatment.*—Immediate suture of the tendon. The thigh and leg are placed in a fracture-box and the fracture-box elevated so that the leg is extended on the thigh and the thigh flexed on the pelvis. This is continued for about three weeks. If operative treatment is refused, use a long fracture-box and strap the patella up in place on a posterior splint. The leg should be extended on the thigh, and the thigh flexed on the pelvis.

Define torticollis. Give the differential diagnosis of torticollis and cervical caries.

Torticollis, or wry-neck, is a deformity due to contraction of certain muscles on one side of the neck. The sternomastoid is first affected, but the trapezius, splenius, the platysma, and even the cervical fascia may also be involved.

In *cervical caries* motion in all directions is restricted, and pain is elicited by pressing upon the cervical vertebræ; in *torticollis* motion is restricted in but one direction—that in which the muscles involved are put upon the stretch. In caries there may be bulging seen or felt in the posterior pharyngeal wall.

DISEASES OF JOINTS

How can the danger of ankylosis be averted after injury to a joint?

By rest and the early employment of massage and passive motion.

Describe the surgical methods for the re-establishment of joint function in confirmed ankylosis.

Chiseling out the bones and interposing a strip of fascia or muscle; if this fails, resection of the joint.

How should ankylosis of the jaw be treated?

Chisel out the condyle and reflect a broad band of fascia between the condyle and the fossa made for its reception (Murphy).

What are the varieties of ankylosis?

Ankylosis may be complete (bony) or incomplete (fibrous); it may arise from contractures in the joint (true or intra-articular) or from contractures in the structures external to the joint (false or extra-articular).

What are the principal affections of synovial bursæ?

Acute simple bursitis, acute suppurative bursitis, chronic bursitis with effusion (housemaid's knee), chronic tuberculous bursitis, syphilitic and gouty deposits.

Define the following terms: (a) bursitis, (b) bunion, and (c) paronychia. Give the treatment for each disease.

(a) *Bursitis.*—Inflammation of a bursa. *Treatment.*—Pressure and rest.

(b) *Bunion.*—An enlargement of one of the bursæ about the foot, usually placed on the inner side of the metatarsal joint of the great toe. *Treatment.*—Correctly made shoes and removal of pressure; if these fail, removal of the inner end of the phalanx and the exuberant bone on the inner surface of distal end of the first metatarsal bone.

(c) *Paronychia.*—Acute, septic inflammation involving the tendon-sheath, tissues superficial to it, or the periosteum; one or all of these structures may be involved. *Treatment.*—Early free incision with thorough disinfection followed by wet bichlorid dressing, dressed daily until healed. Always place on a splint.

The term paronychia is also used to describe inflammation around the nails (whitlow).

Where are the swelling and fluctuation most prominent in synovitis of the ankle-joint?

Between the external malleolus and the tendon of the communis digitorum and between the internal malleolus and the tendon of the tibialis anticus.

DISEASES OF BONES

Mention the inflammatory diseases of bone.

Periostitis, ostitis, and osteomyelitis.

Give treatment of acute suppurative osteomyelitis.

Apply a tourniquet, sterilize the parts, expose and curet the medullary cavity, remove loose fragments of bone, irrigate the medullary cavity with hot salt solution, and pack with iodoform gauze. Dress with hot antiseptic fomentations, and secure rest for the parts by splints and bandages. Remove dead bone subsequently when it becomes loose.

Give the diagnosis and treatment of Pott's disease.

The symptoms of Pott's disease are: rigidity of the spine, detected by getting the patient to pick up an object from the floor, or to rise from a dorsal recumbent posture. In consequence of the rigidity and tenderness the gait is shuffling and uncertain. Pain and tenderness are elicited at times by jarring the head, by inducing the patient to jump from a chair or step, or by direct pressure. There is a constant tendency to support the back; the patient will frequently lie down and, when sitting up, will support the weight of the shoulders on the thighs. Reflex irritation is common. Lumbar disease is frequently attended with colicky pain, irritation of the bladder, and incontinence of urine. Cervical disease may cause torticollis, also difficulty in deglutition. The deformity consists in an undue prominence of the spinous processes, causing a backward projection. Abscesses frequently develop. Paralysis is a late symptom.

Treatment.—Constitutional: As for other tuberculous affections. Local: Rest—in the early stages, rest in bed. Plaster jacket with entire or partial confinement to bed. At times extension will relieve pain and correct the deformity. Abscesses should be opened early.

How may a quart of normal salt solution be prepared at the patient's home?

By dissolving two teaspoonfuls of salt in a quart of boiled water. The salt may be sterilized by baking it in the oven.

What is shock, and how should it be treated?

Shock is a sudden depression of the vital powers arising from an injury or a profound emotion acting on the nerve-centers and inducing exhaustion or inhibition of the vasomotor mechanism. *Treatment.*—In ordinary shock raise the feet and lower the head, unless this position causes cyanosis. Wrap the patient in hot blankets and surround him with hot bottles. Infuse normal salt solution into the cellular tissues (hypodermoclysis), into a vein (intravenous infusion) or into the rectum (enteroclysis). At the same time have the extremities bandaged. The value of the salt solution is increased by the addition of adrenalin chlorid in the proportion of 1:50,000. If shock develop during an operation, the operation must be hurried or even stopped, and proper treatment must be instituted at once. The general opinion is against operating during shock, excepting when death without instant operation is inevitable. If hemorrhage is the cause, the bleeding must be arrested.

What agents are employed for the production of general anesthesia?

Nitrous oxid, ether, chloroform, ethyl chlorid, somnoform (scopolamin and morphin).

What are the contraindications respectively to the use of the three principal general anesthetics?

Nitrous oxid is counterindicated in arteriosclerosis; ether, in pulmonary affections; chloroform, in cardiac diseases.

What are the various methods of administering ether?

Ether may be administered by the open or by the closed method, the former being practically universal in this country. The administration of ether may be preceded by the inhalation of nitrous oxid, ethyl chlorid, or chloroform (mixed anesthesia).

What agents are employed for the production of local anesthesia?

Ice and salt, ethyl chlorid, cocain, and eucain by infiltration and direct application.

HEMORRHAGE

What are methods of controlling hemorrhage?

Exposure to air, cold or hot water, elevation, direct pressure, styptics, cauterization, acupressure, suture, torsion, and ligation.

Describe intermediate and secondary hemorrhage, giving both preventive and curative treatment of each.

By *intermediate* hemorrhage is meant a hemorrhage recurring within forty-eight hours of an operation or accident. *Preventive Treatment.*—The proper method of tying the ligatures, which should include the artery alone, and not the surrounding tissues. All bleeding-points should be carefully and completely controlled at the time of injury, and stimulants should not be injudiciously employed. *Curative Treatment.*—Elevation and pressure. If these measures are not successful, the wound should be re-opened, irrigated with hot salt solution, and all bleeding points tied. If ligatures cannot be applied, the actual cautery may be used or the wound packed with antiseptic gauze.

By *secondary hemorrhage* is meant any hemorrhage occurring in a wound after the lapse of forty-eight hours. *Preventive Treatment.*—Thorough asepsis, the proper application of ligatures to all bleeding points, and the avoidance of the injudicious use of stimulants. *Curative Treatment.*—This will depend upon whether the hemorrhage comes from the end of a divided artery or from an artery which has been ligated in its continuity. If the hemorrhage comes from the end of an artery, elevate and apply pressure. If this does not stop the bleeding, open the wound and ligate; if possible, pack with gauze or resort to the cautery. If the hemorrhage comes from an artery which has been ligated in its continuity, the same local treatment should be adopted as in the former instance. If this is unsuccessful, ligate higher up.

What are the causes of secondary hemorrhage?

1. Constitutional conditions which interfere with organization, or are associated with an overacting heart, such as Bright's disease, diabetes, hemophilia, traumatic delirium, septicemia.

2. Diseases of the arterial walls, as atheroma, syphilis, or tuberculosis.

3. The presence of sepsis. The sloughing may involve the arterial walls.

4. Defect in the ligature or its application.

How should hemorrhage from the liver occurring in the course of an operation be controlled?

By suture; by packing with gauze; by ligature; or by the thermocautery.

Describe the following forms of sutures: interrupted, button, continued, buried, and secondary.

The *interrupted suture* consists of a number of single stitches, each one being independent of its neighbor. The *button suture* consists in passing the threaded needle through an eye of a button, then through the edges of the wound and a button on the other side, back through the other eye of the last button, then through both sides of the wound the reverse way, and, finally, through the remaining eye of the first button; tie both ends together over the button. In a *continued suture* the suture traverses the wound continuously in the same direction, being tied only at the beginning and at the end. A *buried suture* is one completely covered by, and not involving, the skin. *Secondary sutures* are those which are introduced at some time subsequent to an operation—usually two or three days later.

How would you arrest epistaxis?

Apply cold or hot water, pressure, or a solution of adrenalin or melted gelatin. If these methods are inefficient, cauterize the bleeding point, if possible, with silver or chromic acid. When this fails, the anterior nares should be packed with a strip of sterile gauze, the initial extremity of which is carried well back toward the nasopharynx. In rare cases it may be necessary to plug the posterior nares by means of Bellocq's cannula or a soft-rubber catheter.

Describe the symptoms and give the treatment of hemorrhage from the middle meningeal artery.

Symptoms.—The first symptoms are those of concussion. These are followed by a temporary return of consciousness and the gradual onset of coma within twenty-four hours, usually without any rise in the temperature. Since the blood-clot presses upon the motor area, localized twitchings or paralyses may be present. The paralysis is apt to be progressive, commencing in the face on the same side and then extending to the arm and leg of the opposite side from the injury. If the clot gravitates toward the base, the pupil of the same side will be dilated and immobile; the pulse will be frequent, the respirations slow and stertorous. If the clot is on the left side, aphasia will be present.

Treatment.—A semicircular flap consisting of skin and muscle is turned down with its center $1\frac{1}{4}$ in. behind the external angular process, and $1\frac{3}{4}$ in. above the zygoma. The pin of the trephine is placed upon the above point and the skull trephined, the opening being enlarged with rongeur forceps as much as necessary, the cavity thoroughly irrigated, and the clots removed. If the artery is still bleeding, it should be ligated by passing a ligature beneath the bleeding-point with a fine curved needle. Drainage should be provided for and the wound closed in the usual manner.

LIGATIONS

What are the steps in the ligation of arteries?

Incision—dividing the skin and superficial fascia at an angle of about five degrees to the course of the artery; division of the deep fascia; recognition of the muscular or bony guide and the location of the vessel by its pulsation; opening of the sheath; passage of the aneurysm needle; tying of the ligature and closure of the wound.

Under what circumstances should an artery be ligated in its continuity? What instruments are required for the operation?

An artery should be ligated in its continuity to check hemorrhage, to promote the cure of an aneurysm, to diminish the rate of growth of a tumor, to reduce the blood-supply of an organ, and as a preliminary step to the removal of some vascular structure, such as the tongue. The instruments required are: scalpel, dissecting-forceps, retractors, grooved director, scissors, several hemostats, aneurysm needle, and sutures.

What are the indications for ligature of the lingual artery? Give the steps of the operation, omitting aseptic details.

The lingual artery is most frequently tied as a preliminary procedure to removal of the tongue. Other indications for its ligation are to control hemorrhage from the artery or its branches, to check the growth of advanced carcinoma of the tongue, and in certain cases of macroglossia.

Operation.—The patient should be on his back, his shoulders raised, and the head extended and turned to the opposite side. Starting just below the symphysis of the jaw, an incision is made which passes downward and outward to the greater cornua of the hyoid bone, and then upward to the angle of the jaw. This incision divides the skin, both layers of the superficial fascia with the inclosed platysma, and exposes a portion of the submaxillary gland. The deep fascia covering the gland is now incised, and the gland loosened and held up by a retractor. Lesser's triangle, formed by the two bellies of the digastric muscle below and the hypoglossal nerve above, is now exposed. The floor of this triangle is formed by the hypoglossus muscle. The stylohyoid and the tendon of the digastric are drawn downward, the lingual vein and the hypoglossal nerve upward, and an incision is carefully made through the hyoglossus muscle just above the hyoid bone. An aneurysm needle armed with a ligature is now passed about the artery, the ligature tied, and the external wound sutured. The artery may also be ligated before it passes beneath the hyoglossus muscle.

Describe the operation for ligation of the subclavian artery in its third portion.

The patient should be in the dorsal position, with a cushion beneath the shoulders, the face turned to the opposite side. The skin should be drawn down over the clavicle, and an incision made over the bone extending from the anterior border of the trapezius to the posterior border of the sternomastoid. The skin is then allowed to retract, and the wound will be $\frac{1}{2}$ in. above the clavicle. This incision divides the skin, superficial fascia, platysma myoides, and the superficial layer of the deep fascia. If this

does not give enough room, divide the clavicular head of the sternomastoid. The prevertebral fascia is then incised, the anterior scalene muscle located by its attachment to the scalene tubercle on the first rib, and retracted inward. The phrenic nerve is situated on its upper surface. Care must be taken not to wound the subclavian vein or the pleura. The artery is located to the outer side of the scalene tubercle. The ligature is passed from before backward and from below upward.

How would you expose the brachial artery for ligation in the middle of the arm?

Make an incision 3 in. long in the middle of the arm, in the direction of a line extending from the middle of the clavicle to the middle of the bend of the elbow, with the arm adducted to a right angle. Incise skin, superficial and deep fascia, locate the inner edge of the biceps, retract it outward, bringing the median nerve into view, retract it outward, and the artery will be in view.

Give the indications and methods for ligation of the common carotid artery.

The artery is ligated for aneurysm, for wounds of the artery, to check malignant growths, and as a preparatory procedure to the removal of tumors of the face.

Ligation in the Superior Carotid Triangle.—The patient should be on his back with his shoulders elevated, the head thrown back, and the face turned slightly to the opposite side. An incision 3 in. long is made in the line of the artery (from the sternoclavicular articulation to a point midway between the angle of the jaw and the mastoid process), the center of the incision being opposite the cricoid cartilage. The skin, superficial fascia, platysma, and superficial layer of the deep fascia are to be divided, the sternomastoid muscle drawn outward, the tendon of the omohyoid drawn downward, and the pulsation of the artery sought for beneath the sternomastoid. The sheath is now opened, a threaded aneurysm needle is passed from without inward, the ligature grasped, and the needle withdrawn.

Ligation in the Inferior Carotid Triangle.—The incision is made in the line of the artery from the level of the cricoid cartilage to the sternoclavicular articulation. The remainder of the operation is the same as the above, except that the omohyoid muscle is retracted upward.

Describe the ligation of the femoral artery at any selected point.

Ligation at the apex of Scarpa's triangle. The line of the artery is from a point midway between the anterior superior spine of the ilium and the spine of the pubis to the adductor tubercle on the inner condyle of the femur. An incision is commenced 3 in. below Poupart's ligament, and carried downward for about 3 in. in the line of the artery, dividing the skin, superficial fascia, and fascia lata. If the lymphatic glands are exposed, they may be held to one side or removed. In making the incision the internal saphenous vein should not be wounded. The sartorius muscle should now be located, and beneath this muscle the artery will be found.

Describe the anastomosis which takes place after ligation of the femoral artery at its middle third.

The profunda femoris anastomoses with the articular branches of the popliteal and anastomotica magna; the comes nervi ischiadici, with the branches of the popliteal; the circumflex, with the articular branches of the popliteal and anastomotica magna.

What arteries need ligating in amputation at the middle third of the leg? Describe a method of ligating.

The anterior and the posterior tibial and the peroneal. Grasp the vessel with a hemostat and free it from the surrounding tissues; pass a ligature around the vessel and tie one knot, then take off the hemostat, tighten the ligature, and tie the second knot.

NERVES

What symptoms follow division of the facial nerve outside of the skull?

Paralysis of the same side of the face without implication of the palate or uvula. The paralyzed side of the face is immobile, devoid of expression, and the natural folds and wrinkles are obscured. The eyelids cannot be completely closed, the eyeball rolling upward and outward when forcible closure is attempted. Epiphora is present from the drooping of the lower lid. The lips cannot be firmly closed, and whistling is impossible. If attempts are made to move the face, marked asymmetry is produced, the face being drawn toward the non-paralyzed side. Owing to the paralysis of the buccinator, food collects between the teeth and the cheek.

How is resection of the spinal accessory nerve effected? What are the reasons for this operation?

An incision is made along the anterior border of the sternomastoid muscle, extending from the mastoid process to the cornu of the hyoid bone. This incision divides skin, superficial fascia, platysma, and the deep fascia. The sternomastoid is now drawn outward, and the nerve can be felt below the transverse process of the atlas. The nerve emerges from beneath the posterior belly of the digastric, and lies upon the levator anguli scapulæ, beneath the prevertebral fascia. It enters the deep surface of the sternomastoid midway between its two borders, and 1 in. below the tip of the mastoid process. A portion of the nerve is excised, the ends turned in the opposite direction, and sutured in place. The spinal accessory nerve is excised for spasmodic torticollis of central origin.

Give the symptoms and treatment of section of the median nerve.

If the nerve is divided just above the wrist, there will be anesthesia over the radial side of the palm, over the palmar aspect of the thumb, index, middle, and half of the ring fingers, and over the dorsal aspect of the terminal phalanges of the same fingers. There will be paralysis of the outer group of the short muscles of the thumb, as a result of which abduction is impaired, the thumb remaining by the side of the fingers. The outer two lumbricals are also paralyzed, causing loss of power of

flexion of the index and middle fingers at the metacarpo-phalangeal articulation. If divided at the bend of the elbow or in the arm, there will be, in addition to the previously mentioned symptoms, a loss of pronation, loss of power in the hand-grasp, particularly on the radial side, with probable hyperextension of the wrist.

Treatment.—The wound is to be enlarged, if necessary, the ends of the nerve found and sutured together with fine catgut; a domestic sewing-needle without cutting edges should be employed. If the ends cannot be brought together, the nerve may be lengthened or sutured as near together as possible. The nerve-ends will gradually grow together. Massage and electricity should be given daily after the first week.

What symptoms follow division of the radial nerve?

Anesthesia over the radial half of the dorsal surface of the wrist, hand, and the first, second, third, and radial half of the ring fingers, excepting over the terminal phalanges.

What are the symptoms when the ulnar nerve has been divided on a level with the pisiform bone?

Paralysis of the muscles of the little finger, of the inner half of the flexor brevis, and the adductor pollicis. It becomes impossible to adduct the thumb, and the majority of the movements of the little finger are abolished. Flexion of the ring and little fingers at the first joint is impossible. A condition known as claw-hand is produced by the opponents of the interossei, acting without normal antagonism; it consists in overextension of the first phalanges and flexion of the others. The area of anesthesia in ulnar paralysis is the ulnar half of the hand, both front and back, the little and half of the ring fingers, both front and back.

DISLOCATIONS

What is a dislocation? Define the various kinds of dislocation.

The displacement of the articular surfaces of one or more bones of a joint from their normal relation to each other.

Classification in regard to cause: *traumatic*, due either to violence or muscular action; *pathologic*, due either to alterations of the joint from disease or to paralysis of the surrounding muscles; *congenital*, due to congenital malformation of the joint. Classification as to degree: *complete*, an entire separation of the articular surfaces from each other; *partial*, the articular surfaces remain in contact through a portion of their surface. Classification as to time: recent, when sufficient time has not elapsed for inflammatory changes seriously to impede reduction; old, when such changes have taken place.

The terms simple, compound, and complicated are applied to luxations precisely as in the case of fractures.

Mention the causes of dislocation. Give the cardinal symptoms of dislocation.

Predisposing Causes.—(1) The anatomic peculiarities of the joint; (2) active adult life; (3) male sex. *Exciting Causes.*—(1) External violence (direct or indirect); (2) muscular action.

Symptoms.—(1) An alteration in the shape of the joint; (2) an alteration in the length of the affected member (shortening or lengthening); (3) an alteration in the direction of the axis of the extremity; (4) the displaced articular extremity is frequently felt in an abnormal position; (5) more or less immobility of the affected joint; (6) pain, swelling, and ecchymosis.

What articular changes take place in dislocation? What are the general principles governing the treatment of dislocation?

Laceration of the ligaments and the capsule of the joint, and a change in the mutual relations of the articular ends of the bones. If the dislocation remains unreduced, the cavity of the joint becomes filled with granulation tissue and the displaced and lacerated tissues become condensed about the head of the dislocated bone. Any irregularities of the dislocated bone become rounded off, and the surrounding tissues form a false joint.

Principles of Treatment.—Relaxation of the muscles about the joint; reduction of the dislocation by causing the dislocated bone to enter the capsule through the same rent which it made upon leaving it (by manipulation, extension, and counterextension); fixation of the parts after reduction, followed by massage, and active and passive motion after about ten days.

Mention obstacles to reduction of dislocations.

Muscular resistance, anatomic peculiarities of the joint, the interposition of a portion of the capsular ligament or a muscle, fracture of the bone involved, and the presence of adhesions (old dislocations).

Mention the accidents that are liable to occur during the reduction of a dislocation.

Fracture of the bone, rupture of the vessels, and injuries to the nerves.

Outline the principles of treatment for a compound dislocation.

Reduction, immobilization, and antiseptic treatment of the wound.

Describe a method of reduction of a dislocation of the inferior maxillary bone.

The patient is seated; the surgeon stands behind the patient and presses down upon the molar teeth with his two thumbs, which are guarded by a towel. This pressure is continued in a downward and backward direction until the condyle clears the eminentia articularis; then the chin is to be raised by the fingers, and the condyle snaps in place. The jaw should be kept at rest for four or five days by a Barton bandage.

Mention the varieties of dislocation of the clavicle. Describe the treatment of one variety.

There are three forms of dislocation of the *sternal end* of the clavicle, namely: forward, backward, and upward. Dislocation of the *acromial end* is almost always upward, but it may be below the acromion. Treatment of forward dislocation of the sternal end. To reduce the dislocation pull

the shoulders back against the knee of the surgeon, which is placed between the scapulæ. Dress with a posterior figure-of-eight bandage, the bandage to be worn for three weeks; after removal of the dressing apply a truss, the pad of which is put over the head of the clavicle; the truss is worn for one month. If this fails to keep the bone in place, incise and wire.

Name the varieties of shoulder-joint dislocations.

Subglenoid, subcoracoid, subclavicular, and subspinous.

What are the methods of reduction in subcoracoid dislocation of the humerus?

Reduction by manipulation (Kocher's, Smith's methods). Extension and counterextension. Traction in an outward and upward direction.

Describe any one of the dislocations of the shoulder-joint and the mode of reduction.

Subcoracoid is the most common of the shoulder dislocations. In this dislocation the head of the humerus is felt in the axilla beneath the coracoid process. The shoulder is flattened, and the absence of the head beneath the acromion process is noted. The humerus stands from the side and is somewhat oblique in direction, the elbow being carried back by the latissimus dorsi and teres major muscles. Voluntary movements are usually lost; passively, the arm can be easily abducted, but cannot be so far adducted as to bring the hand upon the opposite shoulder and the elbow to the front of the chest (Dugas' sign). Measurement from the acromion to the external condyle shows about ¾ in. shortening.

Method of Reduction by Kocher's Manipulation.—Flex the forearm on the arm to relax the long head of the biceps; raise the arm from the body to relax the deltoid and supraspinatus; rotate the humerus outward to relax the infraspinatus and teres minor; make forcible traction upon the humerus with one hand, and sweep it to the side of the body and rotate it inward, carrying the forearm across the chest; this method may be assisted by having an assistant place his hand in the axilla and press the bone in place.

Give the symptoms and treatment of luxation of the elbow-joint with special reference to the prevention of ankylosis.

Symptoms.—The three bony points are not in line. They are the two condyles and the olecranon. The ulna protrudes posteriorly. The head of the radius can be felt to rotate out of the normal position.

Treatment.—Place the arm and forearm on an internal right angular splint after reduction. Start passive motion and massage within the first five days.

How would you diagnose and reduce a backward dislocation of the forearm?

In posterior dislocation of the elbow the olecranon projects posteriorly; it is out of line with the condyles, and the distance between it and the condyles is greatly increased. The head of the radius is felt behind the external condyle as a smooth, broad, rounded projection; the articular extremity of the humerus can be felt in front of the elbow, below the joint

crease. The forearm is flexed, supinated, and rigid. Measurements from the external condyle to the styloid process of the radius show shortening.

Method of Reduction.—The patient is seated in a chair; the surgeon places his foot upon a chair, with his knee in the bend of the elbow, and presses against the lower end of the humerus, at the same time flexing the forearm; if this is not successful, use forcible extension of the forearm, followed by flexion.

Mention the methods of reducing the dislocations of the last phalanx.

The methods employed are extension, manipulation, and extreme extension.

Mention the varieties of hip=joint dislocation and describe in detail two of these varieties.

1. Upward and backward on dorsum ilii—*dorsal.* 2. Backward in sciatic notch—*ischiatic.* 3. Forward and downward in obturator foramen —*obturator.* 4. Forward and upon the pubis—*suprapubic.*

Dorsal Dislocation.—In this variety the head of the bone rests upon the dorsum ilii, the trochanter is above Nélaton's line, the ilio-tibial band is relaxed, and there is shortening of 2 or 3 in. If a patient is recumbent and the knees vertical, the foot of the injured extremity touches the bed, but the foot of the sound extremity is free of the bed (Allis's sign). A marked hollow is present in the upper part of Scarpa's triangle, and the head of the bone cannot be felt in its usual position. The thigh is flexed, adducted, and inverted, so that the axis of the femur crosses the lower third of the sound thigh, and the ball of the toe rests upon the opposite instep. The ligamentum teres is torn, and the capsule is lacerated. The small external rotator muscles are usually lacerated, but the ilio-femoral ligament is usually uninjured.

Ischiatic.—The signs of this dislocation are somewhat similar, but less marked than in the preceding one. There is not so much shortening, as the intact obturator internus tendon prevents the head of the bone from traveling upward. The shortening is not more than ½ or 1 in., but it becomes more apparent upon flexing the thigh. The thigh is flexed, adducted, and inverted; the axis of the femur crosses the opposite knee, and the great toe rests against the ball of the great toe of the sound side. Practically the same muscles and ligaments are injured as in the dorsal variety.

What are the complications of dislocation of the hip?

Fracture of the acetabulum, fracture of the femur, rupture of the femoral vessels, paralysis from compression or rupture of a nerve-trunk, and extensive laceration of the neighboring soft parts.

Describe a luxation of the hip=joint and mode of reduction.

Dislocation downward into the obturator foramen. This dislocation is indicated by the following symptoms: flattening of the hip; the head of the bone is felt in its new position and is missed from the acetabulum; rigidity exists; passive motion is slight; a hollow is noted over the great trochanter.

The trochanter is below Nélaton's line and nearer than normal to the middle line. The gluteal crease is lower on the injured side. There is lengthening to the extent of 1 to 2 in. The body is bent forward by the traction upon the psoas and iliacus muscles. The limb is advanced and partially flexed and abducted. The foot is pointed straight ahead, or is a little everted. When the patient is recumbent, extension is impossible; the knees cannot be pushed together without great pain, and the adductor muscles are hard and rigid. *Allis's* sign is absent. Reduce by manipulation if possible; if this fails, by extension.

To reduce by manipulation flex the leg on the thigh and the thigh on the pelvis, and then perform, in the following order, abduction, internal circumduction, and extension.

Give the dislocations of the knee-joint and a method of reduction of any one.

There are four forms—backward, forward, inward, and outward. In simple dislocation give ether, have one assistant extend the leg while another makes counterextension on the thigh, and the surgeon pushes the bone in place.

Mention the dislocations of the ankle-joint. Describe any one, with mode of reduction.

There are five forms of dislocation: outward, inward, forward, backward, and upward. In dislocation backward the foot is shortened, the tibia and fibula project in front, the heel is prominent, and the relation between the malleoli and the tarsus is altered. The method of reducing a dislocation of the ankle-joint is to flex the leg on the thigh and the thigh on the pelvis, and have an assistant make counterextension from the knee, while the surgeon makes extension from the foot and at the same time rocks the astragalus into place.

How are dislocations distinguished from fractures?

Dislocations are characterized by more or less immobility and absence of crepitus. The deformity does not usually recur after reduction. The end of the bone is felt in an abnormal position and rotates with the rest of the bone. Fractures are characterized by preternatural mobility and the presence of crepitus; the deformity usually recurs after reduction.

FRACTURES

Name and describe the different varieties of fracture.

Simple (subcutaneous): No communication with external air. *Compound* (open): Communicates with external air. *Complete:* The entire thickness of the bone is broken. *Incomplete:* The entire thickness of the bone is not broken. *Multiple:* The bone is fractured in more than one place and the lines of fracture do not communicate. *Single:* The bone is fractured in but one place. *Comminuted:* The bone is fractured into a number of fragments and the lines of fracture communicate with each other. *Complicated:* In addition to the fracture, the main artery or nerve of the part is injured or a neighboring joint is dislocated. *Fissured:*

A linear split without displacement. *Stellate:* The lines of fracture radiate from a central point. *Depressed:* There is a crushing in of a portion of the bone. *Impacted:* One fragment is driven into the other. *Transverse, longitudinal, oblique,* and *spiral:* The terms indicate the direction of the line of fracture.

Fractures about joints are classed as: *intracapsular*, within the capsular ligament; *extracapsular*, without the capsular ligament. In young persons epiphyseal separation occurs and constitutes *epiphyseal* fracture.

Mention the different kinds of displacement in fracture. In what directions does the line of fracture extend in the case of the long bones?

Varieties of Displacement.—Transverse, longitudinal, angular, and rotary.

Directions of Line of Fracture.—Transverse, longitudinal, oblique, spiral, V-shaped, and T-shaped.

Define a fracture. Give the causes, symptoms, and varieties of fracture.

A fracture is a sudden solution of the continuity of a bone.

Predisposing Causes.—Advanced age, male sex, and diseased conditions of the bone.

Exciting Causes.—Direct violence, indirect violence, and muscular action.

Symptoms.—Deformity from displacement, partial or complete loss of function, preternatural mobility, crepitus, and local signs of trauma.

Varieties.—See page 438.

What fractures do not present mobility? Under what circumstances is crepitus absent?

(a) Impacted fractures, incomplete fractures, and fractures of the skull. (b) In impacted and incomplete fractures, and where there is great separation or overriding of the fragments, or where portions of muscle, tendon, or periosteum are interposed between the fragments.

What are the possible mechanical obstructions in the reduction of fractures?

Muscular spasm, the interposition of muscle or tendon between the ends of the fragments, and impaction of the fragments.

Mention the causes of delayed union and give the treatment.

The constitutional causes are syphilis, rickets, scurvy, osteomalacia, general debility, and pregnancy. The local causes are faulty apposition, mobility, muscle or aponeurosis between the fragments, defective blood-supply, defective innervation, and osteomyelitis.

Treatment.—Remove any local cause and treat the constitutional disease. Change of air, tonics, regulation of the diet, and the administration of phosphorus are beneficial.

Describe the symptoms of fracture of the base of the skull in the middle fossa.

Hemorrhage from the external auditory meatus or nose. Cerebrospinal fluid may be discharged from the external meatus; when present, it is characteristic of fracture in this situation. The facial and auditory nerves may be injured as they pass through the petrous portion of the temporal bone. In addition to these signs, the symptoms of concussion, of compression, or of laceration of the brain may be present.

What is the treatment of depressed fracture of the skull?

Trephine under aseptic precautions, and elevate or remove the fragments.

What are the indications for trephining in fractures of the skull?

Depressed fractures, simple or compound. Symptoms of subdural or extradural hemorrhage.

In what portion of the base of the skull may fractures lead to the escape of cerebrospinal fluid?

Cerebrospinal fluid may escape through the nose in fracture of the anterior fossa involving the cribriform plate of the ethmoid; it may escape through the ear in a fracture of the middle fossa.

Give the symptoms and treatment of fracture at the base of the skull.

Fracture of the anterior fossa is frequently compound, and then one finds subconjunctival ecchymosis and epistaxis. In fracture of the middle fossa there is found hemorrhage from the mouth and ear, sometimes with the escape of cerebrospinal fluid The cranial nerves are frequently injured by the fracture, especially the seventh and eighth. In fracture of the posterior fossa there is usually respiratory derangement. The blood gradually accumulates beneath the deep fascia and produces discoloration in the line of the posterior auricular artery (Battle's sign). The cranial nerves are frequently injured in the fossa. Optic neuritis often arises after the first week. In fracture of the base the temperature is subnormal during shock, rises to 100° to 101° F. during reaction, and gradually falls to about normal and remains normal or subnormal unless there be inflammation.

Treatment.—Wash out the nasopharynx with normal salt solution or boric acid, pack the nose with iodoform gauze, and insufflate the pharynx with iodoform. Wash the ear with 1:2000 bichlorid and insufflate iodoform and pack with iodoform gauze; apply an antiseptic dressing. The dressing of the nose and ear should be repeated every three hours. The head should be entirely shaved, and the patient kept in a dark quiet room on a milk diet. The bladder and bowels should be attended to.

What are the symptoms of fracture of the vertebræ? Detail the ordinary treatment.

Symptoms.—In fracture great displacement is unusual, but some is almost always recognizable (irregularity of the spines or angular deformity).

There is pain (which is increased by motion), tenderness, ecchymosis, and motor and sensory paralysis. Priapism, cystitis, and retention of urine often occur.

Treatment.—When fracture exists without any paralysis, apply extension and counterextension with the patient on a water-bed. A plaster cast should be applied early. Fracture with paralysis calls for immediate laminectomy in order to relieve pressure. The bladder should be catheterized every six hours, if necessary, and the bowels regulated.

Give symptoms and treatment of fracture of the nasal bones.

Symptoms.—Pain, tenderness, deformity, epistaxis, deflection of the septum, and, rarely, crepitus, preternatural mobility, or emphysema.

Treatment.—Reduction, with or without an anesthetic, by introducing a padded dressing-forceps into the nasal cavity. After reduction introduce an internasal splint in each nasal cavity. Irrigate the nasal cavities several times a day with warm boric solution. Remove the splints in ten days.

How and in what part of the inferior maxillary bone is fracture most liable to occur, and what is the treatment?

The cause is usually direct violence, but indirect violence (lateral pressure) may fracture the body anteriorly. The most frequent seat of fracture is near the canine tooth.

Treatment.—Correct the deformity with great care and bring the teeth into normal alignment. Take an impression of the teeth and have a plate made. Cement the plate on the teeth after reduction. If it is impossible to have the plate made, use the "Dorrance-Jamison" appliance. If the patient is without teeth, mold a binder's board splint to the jaw, padded lightly with cotton, and hold the lower jaw against the upper by means of a Barton bandage. The patient should receive liquid food and the mouth washed frequently with a boric-acid mouth-wash.

Give the treatment of fracture of the ribs.

The affected side should be firmly strapped with strips of adhesive plaster so as to limit its range of motion. These strips (2 in. wide) should extend beyond the median line, both anteriorly and posteriorly, and are to be applied from below upward, each strip overlapping about one-third of its predecessor. Each strip should be put on while the chest is in a state of forced expiration. If the patient has advanced pulmonary emphysema or bronchitis, strapping is not advisable, and the fracture is left to take care of itself. If the fracture is compound, disinfect the wound, dust with iodoform powder, and apply straps.

State the most common seat of fracture of the clavicle and describe a method of treatment.

At the junction of the outer and middle thirds of the bone.

Three strips of adhesive plaster $3\frac{1}{2}$ in. wide and long enough to encircle the chest and arm are used. A loop is made in the end of the one strip; this loop is secured by stitches and made to encircle the arm close to the axilla, the non-adhesive surface being next to the skin. The shoulder is then drawn backward, and the adhesive strip carried around

the chest from behind forward. The elbow of the injured side is now brought forward and the hand placed upon the sound shoulder. As the loop of the first strip acts as a fulcrum, the shoulder and outer extremity of the clavicle are carried backward. With the arm in this position the end of the second strip is fixed to the sound shoulder, and the strip is then brought downward across the back to the elbow of the injured side (a hole being cut in the plaster to accommodate the olecranon), and upward across the front of the chest and forearm to hold the extremity against the body. A towel should be placed in the axilla, and all contiguous cutaneous surfaces should be separated by pieces of lint after powdering well. This position is to be maintained until union occurs.

Describe the treatment for fracture of the lower end of the humerus.

Reduce the fracture, rub the part with alcohol, dust with talcum powder, and apply a well-padded, anterior angular splint with the forearm fully supinated. Remove the dressings daily and apply massage for six weeks, when the splint can be dispensed with. The patient should carry the arm in a sling for the next two weeks.

What surgical landmarks of the elbow-joint would aid you by their position in diagnosing between a fracture of the upper end of the radius and a posterior dislocation of the ulna?

In fracture the head of the radius does not rotate. The three bony points are in alignment in fracture, while in dislocation the reverse is the case. The bony points are the two condyles and the tip of the olecranon process.

How would you diagnose and treat a case of fracture of both bones of the forearm occurring at the middle third?

The *symptoms* are: pain and tenderness, inability to use the arm, and angular deformity. The *signs* are: crepitus, preternatural mobility; the head of the radius does not rotate with rotation of the lower portion of the forearm; later, swelling and ecchymosis. Have a skiagraph taken to confirm the diagnosis.

Treatment.—Reduction by extension and counterextension, with manipulation of the fragments. Apply a well-padded, straight, anterior splint, extending from the bend of the elbow to the finger-tips, and a posterior splint extending as far as the knuckles.

The forearm should be midway between supination and pronation (thumb up). Be careful not to bandage too tightly on account of swelling. Take off splints every other day for first week. Massage every day after the first week. Remove splints in five weeks.

What is Colles' fracture? How would you treat it?

Colles' fracture is a transverse, or nearly transverse, fracture of the lower end of the radius, between the limits of ¼ in. and 1½ in. above the wrist-joint. The lower fragment sometimes rests upon the dorsum of the upper fragment.

Treatment.—Reduce the deformity by hyperextension, to unlock the fragments and relax the dorsal periosteum; follow by longitudinal traction to separate the fragments, and forced flexion to force them into position. Apply a Bond splint or a posterior straight splint. Passive motion is begun upon the fingers in three or four days, and upon the wrist during the first week. The splint is removed in three weeks, and a bandage is worn for a week or more.

How would you treat a case of fracture through the symphysis of the pubis with a rupture of the urethra?

Perform a perineal section and drain the bladder. In fracture with separation of the pubic bones the bones should be wired together. If no separation exists, the pelvis should be encircled with a canvas binder, and the patient placed upon a Bradford frame.

Describe the treatment for fracture of the shaft of the femur at the middle third.

In setting a fracture of the thigh an anesthetic should be given, and the parts must be handled with great care to prevent a sharp end from tearing the soft parts and puncturing the skin. The surgeon should always feel the pulse below the seat of fracture to see if the artery is damaged. In fracture with impaction the fragments must be pulled apart and the case treated as a simple fracture. The fracture should be reduced and placed in a double-inclined fracture-box with extension in the line of the thigh. The amount of weight required is about one pound for each year up to twenty. Extension should be continued for four weeks, and a plaster-of-Paris bandage used for four weeks more, the patient being then allowed to go about on crutches. Massage should be given after the first week.

Differentially diagnose impacted and non=impacted fracture of the neck of the femur.

Impacted Fracture.	*Non-impacted Fracture.*
Crepitus is absent.	Crepitus may be obtained.
Eversion is less marked and inversion may be present (rare).	Eversion is present.
The head of the femur moves under the finger when the extremity is rotated.	The head of the femur does not move under the finger when the extremity is rotated.
The symptoms of fracture are not so marked.	The symptoms of fracture are more marked.
The individual may be able to walk (but should not be allowed to try).	The individual is unable to walk.
Slight shortening.	Marked shortening.

Give the indications for operating in a compound fracture of the thigh and describe the operation in detail.

The indications are: Infected material in the wound and fragments that will not remain in apposition.

After anesthetizing the patient, the surface of the limb around the wound should be thoroughly washed, shaved, and scrubbed with an antiseptic

solution. The surgeon, with aseptic hands, should then cleanse the wound, remove the blood-clots and fragments of bone, tie the bleeding vessels, suture the divided nerves and tendons, trim the fragments if necessary, cut away contused tissues, make counteropenings for drainage if necessary, and suture the wound. Apply an antiseptic dressing and put the thigh in a double-inclined plane fracture-box or in plaster. If the wound remains clean, treat as a simple fracture; if it becomes infected, provide good drainage and dress daily. Some surgeons suture the bone with silver wire or put in a silver plate. If the wound is small and apparently clean, antisepticize the skin and treat as a simple fracture, after dusting the wound with iodoform powder.

Describe the varieties and the treatment of fracture of the patella.

Varieties.—Transverse, longitudinal, and multiple.

Treatment.—There are two methods: operative and non-operative.

The *non-operative* treatment consists in elevation of the thigh and leg in a long fracture-box (to relax the quadriceps muscle), with adhesive plaster to hold the fragments in apposition, or the use of an Agnew splint. The *operative* treatment is divided into immediate operation and operation after the swelling has subsided. The operation consists in a curved incision above or below the patella, with a dissection down to the fracture, and the removal of blood-clots and fringes of the capsule of the joint. The torn lateral ligaments and capsule are sutured. Some surgeons suture the bone with silver wire.

The *after-treatment* consists in elevation of the leg for four weeks, with massage after the first week. After four weeks a plaster cast should be applied for three weeks and the patient allowed up on crutches.

Describe Pott's fracture. Name the structures involved and outline the treatment.

Pott's fracture is a fracture of the lower fifth of the fibula, produced by eversion and abduction of the foot. If eversion is the sole or main movement, the force is exerted through the internal lateral ligament and breaks the internal malleolus squarely off at its base; then it presses the external malleolus outward, rupturing the tibiofibular ligament, and breaking the fibula close above the malleolus. Sometimes, instead of a pure rupture of the ligaments, there is avulsion of the portion of the tibia to which it is attached.

Treatment.—After reducing the fracture, place the limb in a fracture-box containing a soft pillow and a cotton pad for the heel. A fillet around the ankle fastens the foot to the foot-piece of the box. A pad of cotton should rest between the foot-piece and the sole. A compress is placed below the outer malleolus, and another one above the inner malleolus. Close the sides of the box, tie them together with a bandage, and swing the box on a gallows. Every day the sides of the box should be let down and the leg rubbed with alcohol. In ten days apply a plaster-of-Paris bandage and let the patient go about on crutches. Remove the cast at the end of the fifth week after the accident, and let the patient go about on crutches for one week and with a cane for a week longer.

Give the differential diagnosis between fracture of the neck of the humerus and dislocation of the shoulder-joint.

Fracture.	*Dislocation.*
Elbow readily approximated to side.	Elbow cannot be approximated to side without causing great pain.
Elbow can be made to touch chest with hand of affected extremity upon the sound shoulder.	Elbow cannot be made to touch chest with hand of affected extremity upon sound shoulder (Dugas' sign).
Crepitus present.	No crepitus.
Preternatural mobility present.	No mobility.
Shape of shoulder-joint unchanged.	Flattening of shoulder-joint, the head of the bone being felt in an abnormal position.
Deformity recurs after reduction.	Deformity does not recur after reduction.
Shortening of the arm.	Elongation may be present, or the arm may be of normal length.

Differentiate dislocation of the head of the femur from fracture of its neck, and give essentials of treatment of each.

Dorsal Dislocation.	*Intracapsular Fracture.*
Inversion of the foot.	Eversion of the foot.
Immobility.	Preternatural mobility.
Head of femur not felt in its natural position.	Head of femur felt in its natural position.
The buttock of the affected side is unduly prominent, due the presence of the head of the femur.	Flattening of the hip, with the great trochanter moving in an arc of smaller radius, and relaxation of the iliotibial band.
Crepitus is absent.	Crepitus may be elicited (unless impaction is present).
Immediate shortening of 2 or 3 in.	Immediate shortening of ½ in., consecutive 2 or 3 in.
Rarely occurs after forty-five, and more common in the male.	Much more common in advanced life and in the female.
Violence usually considerable.	Violence usually trivial.

Treatment: Dislocation.—Reduction by flexion of leg upon thigh, flexion of thigh upon abdomen, external circumduction, and extension. When reduction has been effected, the knees should be bandaged together and the patient kept in bed for two weeks.

Fracture.—Reduction by extension and counterextension. Buck's extension should be applied with about fifteen pounds of weight. A sand-bag extending from the axilla to the external malleolus should then be placed upon the outer side of the extremity, and one extending from the groin to the internal malleolus upon the inner side of the extremity. In some cases it may be advisable to apply a cast from the knee up to the middle of the abdomen, and allow the patient to change her position, or one may use Thomas' ambulatory splint and allow the patient to get up and use crutches.

Differentiate between a dorsal dislocation of the hip and tubercular coxitis.

In *dorsal dislocation* the limb is shortened, the foot inverted, the great toe rests on the dorsum of the opposite foot, and the head of the femur is felt in an abnormal position. When reduced, it usually stays in place.

In *coxitis* the patient complains of pain in the knee and pain when the thigh is rotated; the spine is in a condition of lordosis when the thigh and leg are extended and there is apparent lengthening. The patient is usually more comfortable with the thigh flexed upon the abdomen.

ORTHOPEDIC SURGERY

Describe an operation for wry-neck.

Open tenotomy of the sternal and clavicular heads of the sternocleidomastoid muscle by means of an incision parallel with the clavicle, starting from the suprasternal notch and extending outward for 2 in., dividing the skin, fascia, and sternal and clavicular portion of the muscle. Control hemorrhage, suture the wound without drainage. Hold the head in an overcorrected position and apply a plaster cast.

Describe an operation for the cure of webbed fingers.

Didot's Operation.—A flap the length of the finger and half its width is taken from the dorsal surface of one finger and the palmar surface of the other. Each of these flaps is carefully applied to the denuded area upon the finger, to which it is attached and secured by sutures.

Describe the several varieties of club-foot.

In *talipes equinus* the heel is drawn up and the patient walks upon his toes and the heads of the metacarpal bones. In *talipes calcaneus* the toes are raised from the ground and the patient walks upon his heel. In *talipes varus* the anterior half of the foot is adducted, the inner side of the foot is raised, and the patient walks upon the outer side. In *talipes valgus* the anterior half of the foot is abducted and everted, the patient resting on the inner side of the foot. Various combinations of these forms are indicated, as follows: Talipes equinovarus, talipes equinovalgus, talipes calcaneovarus, and talipes calcaneovalgus.

Describe talipes equinus and give its treatment.

In talipes equinus the heel is drawn up so that the patient walks upon the metatarso-phalangeal joints and the toes. The degree of deformity ranges from those cases in which there is simply a slight elevation of the heel to those in which the foot is almost vertical, and the plantar muscles and fascia so contracted that the patient walks upon the metatarsal bones, the toes being in a position of overextension.

Treatment.—The mild cases may be treated by manipulation and plaster bandages, but subcutaneous division of the tendo Achillis is usually required. The foot is subsequently placed in its normal position and put in plaster-of-Paris. The foot is kept in plaster for three months, and a mechanical support, rendering extension beyond a right angle impossible, must be worn for a year. In severe cases it may be necessary to divide the plantar fascia and elongate the tendo Achillis. In the most obstinate cases some surgeons excise the astragalus or perform a cuneiform osteotomy.

Describe in detail the condition known as talipes equinovarus.

In talipes equinovarus the heel is drawn up and the anterior half of the foot is adducted and drawn inward. The inner border of the sole is con-

cave, and traversed by a sulcus corresponding to the position of the mid-tarsal joint. The outer border is convex. The sole of the foot is arched from secondary contraction of the plantar fascia and some of the plantar muscles, and its center may be marked by a longitudinal crease due to a folding over of the outer metatarsal bones. The patient walks upon the outer border of the foot. In acquired cases the extensor and peroneal muscles are paralyzed; the tibialis anticus, tibialis posticus, flexor longus digitorum, and the tendo Achillis are secondarily shortened.

Give the treatment for talipes calcaneus.

Division of the flexor tendons. If the tendo Achillis is attenuated, it should be shortened. In other cases the tendon of the peroneus longus may be grafted into the tendo Achillis. In the paralytic variety some form of apparatus must always be worn.

Give the differential diagnosis of congenital talipes equino-varus and paralytic talipes equinovarus.

In *congenital* talipes equinovarus the affection exists from birth; it is usually bilateral, the circulation is good, there is but little wasting of the muscles, the electric reactions are not much impaired, the growth of the bones is as much as usual, and furrows are present in the sole. In the *paralytic* variety the affection is not developed until the second or third year, and is usually due to anterior poliomyelitis. It is usually unilateral; the circulation is feeble; the muscles show extreme wasting; electric reactions are almost entirely absent in the paralyzed muscles; the growth of the bones is considerably diminished, and there are no furrows in the sole.

What is genu valgum? State how genu valgum should be treated.

Genu valgum (knock-knee) results from an unnatural growth of the internal condyle, causing the shaft of the femur to curve inward and the internal lateral ligament of the knee-joint to stretch. The knees are close together and the feet widely separated. It may occur in one knee or in both knees.

Treatment.—In mild rachitic cases the patient is forbidden to stand or walk, and the limb, after being put as straight as possible, is fixed on an external splint or held in place by mechanical appliances. In a severe case the surgeon can immobilize after forcibly straightening (causing an epiphyseal separation) or after an osteotomy of the lower end of the femur. Osteotomy is preferable to fracture by a mechanical appliance.

Give the symptoms and treatment of hammer-toe.

Hammer-toe is an angular flexion of one or more of the toes (especially the little and second) at the first phalangeal articulation, the third phalanx being either in line with the second or flexed on it. The proximal phalanx is usually extended. Hammer-toe is the result of contraction of the plantar fibers of the lateral ligaments of the joint. Relief is afforded only by operation. Division of the lateral ligaments by subcutaneous or open method, on the under surface of the first phalanx, but, as a rule, without satisfactory results. If this fails, resect the lower end of the first phalanx. After all the operations the toes should be put on a splint for two weeks.

AMPUTATIONS

Define amputation in the continuity and amputation in the contiguity of a limb.

By amputation in continuity is meant an amputation through the bone or bones of the extremity. By an amputation in contiguity is meant an amputation through any of the joints of the extremity.

What circumstances demand amputation of an extremity?

A crush with devitalization of tissues; compound fracture with rupture of the arteries, or in which osteomyelitis has developed; rapidly ascending gangrene, or gangrene after the line of demarcation has formed; primary malignant growths of bones or recurrent malignant growths of soft structure; for deformity; laceration of the main artery; tabetic joints; caries in the stump or painful stump (re-amputation).

How are amputations classified in regard to time of operating? What period is most favorable for operation?

Primary amputation is performed as soon as the patient reacts from shock and before he develops fever. *Secondary* amputation is performed some time after the accident, suppuration having supervened. *Intermediate* amputation is performed during the existence of fever, but before the development of suppuration.

The primary period is the one most favorable for operation.

Give the method of inserting Wyeth's pins for amputation at the hip-joint.

The outer pin is inserted 1½ in. below, and a little internal to the anterior superior spine of the ilium, and is brought out just back of the great trochanter. The internal pin is entered 1 in. below the spine of the pubis and internal to the saphenous opening; it emerges 1½ in. in front of the tuberosity of the ischium.

The periosteum and muscles should be sutured over the end of the bone and the edges of the flaps united by interrupted sutures.

Describe a method of amputation of the thigh.

Flap amputation through the skin and circular through the muscles—so-called mixed method. After all aseptic precautions have been observed and a tourniquet applied, the surgeon takes his position upon the right side of the extremity to be amputated and makes a straight incision upon each side of the thigh. These incisions commence at the level at which the bone is to be divided; they are one and a half times as long as the diameter of the limb at their point of origin, and divide the skin and subcutaneous tissue. The lower ends of these incisions should be connected by an anterior transverse incision, and the corners of the flaps rounded off. The anterior flap, consisting of skin and subcutaneous fat, is now raised. The posterior flap is then dissected up. The muscles are divided by a circular sweep of the knife. An assistant retracts the muscular tissue, a cuff of periosteum is raised, and the bone is sawn through as high up in the wound as possible. After the main vessels have been secured, the tourniquet should be loosened and all bleeding points caught and

ligated. The large nerves are drawn out and divided with scissors at the highest possible level, any projecting tendons are retrenched, and capillary hemorrhage checked by hot saline solution.

Describe a modified circular amputation of the leg.

Cut semilunar skin-flaps, lay them back, and cut circularly to the bone at the edge of the turned-up flap. Another method of modified circular amputation consists in adding to the circular cut a vertical incision down the front of the leg. In sawing the bones of the leg the surgeon, who stands to the outer side of the right leg and to the inner side of the left leg, divides the fibula first and at a higher level than the tibia, and bevels the anterior surface of the tibia. In sawing the left fibula the saw points to the floor; in sawing the right fibula it points to the ceiling.

Describe Syme's method of disarticulation at the ankle-joint.

The foot is held at a right angle to the leg and a skin incision is carried, from just below the external malleolus, straight across the sole to a corresponding point on the opposite side. Do not take this incision near to the inner malleolus, as to do so will endanger the posterior tibial artery. The incision is carried to the bone, the flap being pushed back and separated from the bone by means of a strong knife and the thumb-nail until the tuberosity of the os calcis has been reached. The foot is now extended and a transverse cut is made across the dorsum, joining the two ends of the first incision; the ankle-joint is opened, the lateral ligaments are cut, disarticulation is effected, and the foot is finally completely removed by severing the tendo Achillis. A thin piece of bone, including both malleoli, is sawn from the tibia and fibula. The flap is perforated posteriorly to secure drainage.

Describe Pirogoff's method of amputation.

The same as Syme's method, excepting that the posterior surface of the os calcis is sawn across and the flap with the posterior portion of the os calcis is sutured in place.

Describe disarticulation through the middle tarsal joint—Chopart's operation.

Make a transverse incision through the skin of the instep, 2 in. below the ankle-joint; cut the tendons and muscles, expose the tarsus, and make on each side a small, longitudinal incision reaching to below, and in front, of the corresponding malleolus. The plantar flap is made as in Lisfranc's amputation. Open the astragalo-scaphoid joint, then the calcaneo-cuboid joint, and disarticulate. Stop the hemorrhage, retrench the tendons, and suture the skin wound.

Describe disarticulation at the tarsometatarsal articulation.

Lisfranc's Operation.—Performed with a long plantar and a short dorsal flap. Disarticulate between the cuneiform and metatarsal, the cuboid and metatarsal bones.

Hey's Operation.—The method is practically the same as that of Lisfranc's. The four outer metatarsal bones are disarticulated, but the first metatarsal is removed by sawing off a portion of the internal cuneiform bone.

Describe a method of amputation of the last phalanx.

Make a dorsal incision over the interphalangeal joint, cut the lateral ligaments, disarticulate the last phalanx, and cut the palmar or plantar flap from within outward. It should extend to the end of the finger.

Describe disarticulation at a metacarpo-phalangeal joint.

The Racket Method.—The incision upon the dorsum is begun just above the head of the metacarpal bone; it is carried down to beyond the base of the phalanx and involves the skin only. One incision sweeps around the finger at the level of the web, going through the skin; the finger is extended and the palmar cut is carried to the bone; each lateral incision is carried to the bone, while the finger is bent in the opposite direction; the flaps are dissected back to the joint, the finger is strongly extended, the joint is opened from the palmar side, and disarticulation is effected.

Describe disarticulation at the wrist-joint.

A circular incision is made, 1½ in. below the styloid process of the radius, the tendons divided, and the disarticulation accomplished.

Describe disarticulation at the elbow-joint.

It can be performed by the elliptic, or by a long anterior and short posterior flap method.

Describe one method of amputation at the shoulder-joint.

Larrey's Method.—The incision begins just below, and in front of the acromion process, and passes vertically downward for 4 in. From the center of this incision an oval incision is carried around the arm. The anterior structures are divided close to the bone, and the posterior structures are next cut. To disarticulate, cut the capsule transversely upon the head of the bone; while the arm is rotated outward, cut the subscapularis, and while the arm is rotated inward, cut the supraspinatus, infraspinatus, and the teres minor muscles. Cut away any tissue holding the humerus to the body, stop all hemorrhage, and suture the skin wound vertically.

Describe the method of insertion of Wyeth's pins for shoulder-joint amputations.

The anterior pin is entered at the middle of the lower margin at the anterior axillary fold, and emerges 1 in. within the tip of the acromion. The posterior pin is entered at a corresponding point on the posterior axillary fold, and emerges on the posterior surface of the scapula, 1 in. within the tip of the acromion.

EXCISIONS

What are the conditions which render excision of the lower jaw advisable?

Malignant tumors of the mandible; malignant tumors in the adjacent tissues involving the bone secondarily.

How is resection of the elbow-joint performed?

The forearm is flexed and held across the chest of the patient by an assistant. A vertical incision 5 in. in length is made along the back of the joint, the center of the incision being to the inner side of the tip of the olecranon. This incision goes down to the bone. The tendon of the triceps is now divided close to the olecranon. The tissues are separated from the lower end of the humerus and the upper end of the ulna, being careful not to injure the ulnar nerve or the insertion of the biceps and brachialis anticus. The ulna and radius are divided just below their articular surfaces; the lower end of the humerus is next resected. All diseased synovial membrane and granulation tissue must be dissected away, all bleeding points caught and ligated. The divided end of the triceps and the fascia are sutured in place. The wound is closed with or without drainage, as the case requires.

What are the indications for excision of the knee-joint?

Tuberculous disease, disorganization of the joint after pyemia or osteoarthritis, old neglected cases of infantile paralysis where there is a flail-limb, and deformity due to bony ankylosis in a bad position.

Describe resection of the knee-joint.

A semilunar incision, extending from either side of the joint to a point 1 in. below the tuberosity of the tibia. Dissect up this flap; divide the patellar tendon and the lateral ligaments. Take out the patella and divide the crucial ligaments; saw off the lower end of the femur at right angles to the shaft, from behind forward. Saw the upper end of the tibia from behind forward. Remove all diseased tissue. Suture the patellar tendon and the lateral ligaments in place. Suture the skin-edges together, with or without drainage.

TREATMENT OF WOUNDS

How are wounds classified?

Incised, lacerated, contused, punctured, poisoned, and gunshot. They may also be divided into septic and aseptic. Wounds in the vicinity of great serous cavities are divided into penetrating and non-penetrating.

What are the sources of wound infection?

The foreign body making the wound; the skin of the patient; the hands of the surgeon; solutions, instruments, ligatures, sutures, dressings, and, at times, aërial infection.

Describe the steps in the treatment of a scalp wound.

Hemorrhage is to be controlled by pressure or ligation. The scalp should be shaved for a distance of several inches from the margins of the wound. All foreign substances are removed and the wound disinfected with an antiseptic solution. The wound should now be sutured with silkworm-gut, and a moist bichlorid dressing (1:4000) applied. If the wound subsequently shows signs of infection, one or more of the sutures should be immediately removed, the wound again disinfected, packed with gauze, and allowed to granulate.

Describe the aseptic and the antiseptic methods of treatment of wounds.

In the aseptic method heat, chemical germicides, or both are used to cleanse the instruments, the field of operation, and the hands of the surgeon, the surface being freed from the chemical germicide by washing with boiled water or saline solution. After the incision has been made, no germicide is used.

In the antiseptic method the preparations for the operation are the same as in the aseptic method, but during the operation an antiseptic solution, usually bichlorid of mercury, 1:2000, is used instead of sterile water or saline solution, and the sponges, pads, and dressings of the wound are impregnated with the antiseptic solution.

BURNS, ETC.

Give a classification, either original or from competent authority, of burns.

Dupuytren's Classification.—He divides all burns into six classes or degrees: 1. Superficial burns followed by redness and desquamation of the epidermis. 2. Burns followed by the formation of vesicles or bullæ. 3. Burns destroying the epiderm and a portion of the true skin. 4. Destruction of skin and subcutaneous tissue. 5. Deep fascia is penetrated, muscles and tendons are involved. 6. Involving all the constituents of the part.

State the constitutional effects and give the treatment of burns.

Constitutional symptoms are: shock, followed by reaction, in which the patient develops a high temperature, accompanied by vomiting, diarrhea, hemoglobinuria, albuminuria, enlargement of the liver and spleen. From the second to the ninth day the patient may develop meningitis, enteritis, or duodenal ulcer. Death may be caused by exhaustion, decreased excretion, peritonitis, meningitis, and pneumonia.

Local Treatment.—In slight burns moisten the parts frequently with a saturated solution of sodium bicarbonate or 1 per cent. of picric acid. In severe burns cut clothing from body, wrap normal parts in blankets, and surround with hot-water bottles. Clean burned area with dioxid of hydrogen and apply sterile lint saturated with normal salt solution, which is kept continually wet. Change dressings daily. Picric acid (1 per cent.) may be used instead of normal salt solution.

Constitutional Treatment.—Heat, stimulation, and liquid diet; keep the bowels and kidneys active; combat pain with acetanilid, whisky, etc. Opium is contraindicated on account of decreasing excretions.

Give the cause, symptoms, and treatment of chilblain.

Chilblain is a secondary effect of cold. It usually appears as a local congestion upon the toes, the fingers, or the nose, and at times becomes inflamed and ulcerates. Frequent attacks of congestion produce crops of vesicles; these vesicles rupture and expose an ulcer, which in rare instances sloughs. A chilblain is apt to become congested on approaching a fire or on taking exercise, and when congested it itches, tingles, and stings.

Treatment.—Persons once attacked are liable to relapses upon slight provocation Warm woolen socks, gloves, and proper mufflers for the ears and face should be worn. In mild, acute chilblain gentle friction with snow and the application of ice-water, with rest and the use of lead-water and laudanum, will usually effect a cure. In the more chronic forms the following prescription is very valuable: powdered camphor, 1 dr.; ichthyol, 1½ dr.; lanolin, ½ dr.; petrolatum, 4 oz., rubbed into the part and covered with cotton-wool. If vesicles form, paint with contractile collodion; ulcers must be dressed antiseptically. If ulcers are sluggish, use equal parts of resin cerate and spirits of turpentine.

Give the symptoms of shock, and state when the prognosis is grave.

Symptoms.—The skin is pale, cool, and bathed in perspiration; the pulse is rapid and weak; the respirations are shallow and irregular, and the temperature is subnormal. Nausea and vomiting may occur, and the feces and urine may be passed involuntarily. The symptoms vary according to the severity of the injury. The patient may suffer from a sensation of momentary weakness and faintness to a most profound muscular relaxation and unconsciousness. The pupils are dilated and react slowly to light. Shock is frequently followed by suppression of urine. The *prognosis* is grave when a vital part is injured, when the injury is extensive, when a reaction as regards temperature is not observed within four hours after the reception of the injury, when large quantities of blood have been lost, and in old people who are the subjects of degenerative changes. (See also page 428.)

HEAD, NECK, AND CHEST

What diseases attack the antrum maxillæ (Highmore)?

Hydrops, empyema, tuberculosis, benign tumors (chondroma, fibroma, osteoma), and malignant tumors (sarcoma and carcinoma).

What anesthetic would you select for an operation about the mouth?

Chloroform, unless contraindicated.

What is harelip? Give the treatment of harelip.

Harelip is a congenital cleft in the upper lip due to defective development.

Treatment.—The operation for harelip should be performed between the third and sixth months, in a child in good condition.

Give an operation for excision of the tongue for carcinoma.

Kocher's Operation.—The patient is placed in the Trendelenburg sloping position, with complete anesthesia, and without a preliminary tracheotomy. A silk suture is passed through the tip of the tongue as a retracor. An incision is made in the middle line through the lower lip down to the bone, and extending as far as the hyoid bone, forceps being applied to the divided vessels in the lips. The jaw is then sawn through

just outside of the incisor teeth. In order to preserve the geniohyoides and geniohyoglossi on both sides, holes are first bored with a drill a few millimeters from the edge of the surface to be divided. The two halves of the jaw are widely separated, and the tongue drawn out of the mouth and toward the healthy side by means of the silk retractor. The mucous membrane of the floor of the mouth is then divided backward as far as the tonsillar fold on both sides. Ligate the lingual artery and vein, and divide the hypoglossal nerve as it crosses the hyoglossus muscle. The lingual artery passes forward and upward between the hyoglossus and the geniohyoglossus muscles, where it is ligated. The hyoglossus muscle is divided, as in all muscular incisions, immediately outside the limits of the growths, and the edges cauterized. The tongue is then pulled forward, and the mucous membrane divided in the posterior surface of the mouth; the styloglossus muscle and glossopharyngeal nerve are now divided. Lastly, the tongue is cut through, where it is healthy, with the thermo-cautery, and the nerves, muscles, and vessels (previously ligated) are cut through on the under surface. The nerves and muscles are preserved as much as possible, in order not to interfere with the mechanism of swallowing more than is necessary. The two halves of the jaw are then approximated, and silver wire pushed through the holes previously drilled, and the edges of the jaw firmly wired. Always leave a silk suture through the stump of the tongue in case the patient should swallow it. The cutaneous wound is closed by sutures, excepting at the lower end, where a strip of gauze is left for drainage. Dressings are applied, and the patient kept in a sloping position as long as swallowing is much interfered with.

What glandular structures are most commonly affected in carcinoma of the anterior portion of the tongue?

The submental lymphatic glands, the submaxillary, and the glands beneath the sternomastoid muscle. The sublingual and submaxillary salivary glands may also be involved.

What is the treatment of diphtheric stenosis of the larynx?

The usual treatment of diphtheria should be instituted or continued. Injection of diphtheric antitoxin, administration of whisky, hypodermic injections of strychnin, absolute rest in bed, and fluid diet. In stenosis *intubation* should be performed immediately. If the tube becomes plugged continuously or coughed up frequently each day, tracheotomy should be performed.

How would you perform tracheotomy?

Place the patient in the dorsal position, with the head extended over a sand-bag. An assistant holds the head in the middle line. Make an incision in the middle line about 2 in. long from the cricoid cartilage downward, through the skin, superficial and deep fascia; separate the sterno-hyoid muscles, and divide the pretracheal fascia. Stop the hemorrhage and retract the isthmus of the thyroid downward. Steady the tracheal rings with a tenaculum, incise the second and third rings from below upward, insert the tube with the obturator, remove the obturator, and insert the inner tube.

Give the treatment of foreign bodies in the trachea.

Perform low tracheotomy and, if possible, remove the foreign body. If removal at the time of the operation, by means of delicate forceps, coin-catcher, wire loop, or hooked probe, is impossible, the edges of the tracheal wound should be sutured to the cutaneous incision, and the foreign body, if movable, will usually be spontaneously expelled. If the foreign body is not expelled within a day or two, the trachea and bronchi should be examined with an electric tracheoscope. If this is not successful, the foreign body should be located by the x-ray. If all the above methods fail, resect several ribs posteriorly and open the trachea through the thoracic cavity.

What are the indications for thyroidectomy?

Fibro-adenomatous and cystic goiters, parenchymatous goiters which increase in size in spite of palliative treatment, carcinoma and sarcoma of the thyroid gland, and exophthalmic goiter in selected cases.

What are the causes of dysphagia?

1. *Pharyngeal.*—Acute or chronic inflammation, tuberculosis, syphilis, malignant growths, paralysis, nasopharyngeal polypi, and impaction of foreign bodies.

2. *Laryngeal.*—Acute or chronic inflammation, tuberculosis, syphilis, and malignant growths.

3. *Esophageal.*—Acute or chronic inflammation, impaction of foreign bodies, the presence of diverticula, esophagospasm, simple or malignant stricture. Pressure from without caused by aneurysm, goiter, enlarged glands, mediastinal growths, pericardial effusion, and tumors of the vertebræ.

What are the causes of esophageal stricture?

Congenital narrowing, the cicatricial contraction of healed ulcers, carcinoma, polypoid tumors, and external pressure caused by aneurysm, goiter, and sarcoma of the glands of the mediastinum. Stricture near the cardiac orifice may arise from the healing and contraction of a gastric ulcer. Spasmodic stricture occurring in hysteric patients has no local cause.

Give the symptoms and treatment of stricture of the esophagus.

The chief symptom is difficulty in swallowing. The *dysphagia* is first manifested to dry solids, then to all solids, and finally to liquids. In some cases regurgitation occurs after swallowing. If the stricture is high up, the regurgitation is almost immediate; if low down, it is delayed, especially if the canal is dilated above the stricture. The patient feels weak and hungry, becomes exhausted and emaciated, and suffers from flatulence and constipation. The stricture may be located with a bougie and by auscultation over the spine, on a line with the supposed obstruction. If there is no history of injury or syphilis and the patient is over forty years of age, the indications point to cancer rather than to cicatricial stenosis. The easy passage of a bougie when the patient is anesthetized shows that

spasm and not organic disease is the cause. Narrowing due to external pressure is marked by positive symptoms of the causative disease.

Treatment.—Gradual dilatation through the mouth, if possible. If the stricture is situated above the sternum, the next in order is external esophagotomy. If below the sternum, perform a gastrotomy, try retrograde dilatation; if not successful, try to pass a filiform bougie with a silk thread attached to it; with this silk thread, by a sawing movement, perform internal esophagotomy. If nothing can be passed, perform a gastrostomy.

Describe the operation for empyema.

In the case of a child perform thoracotomy in the eighth interspace, midaxillary line, by opening between the ribs. If in an adult, resect one or more ribs. In both cases drain by means of a large rubber tube. If the empyema persists, perform thoracoplasty, which is resection of several ribs for about 3 in.

At what point is paracentesis of the thorax preferably performed?

At the most dependent point of the effusion. The site usually selected is in the *seventh interspace*, just below the angle of the scapula or in the posterior axillary line.

ABDOMINAL SURGERY

What are the indications for the operation of gastrostomy?

Malignant disease of the esophagus; stricture or stenosis of the esophagus from any cause, when the patient is unable to take sufficient nourishment; at times for retrograde dilatation of the esophagus.

Give the surgical palliative treatment of carcinoma of the stomach at the pylorus.

Posterior gastro-enterostomy.

Give the technic of a gastro-enterostomy—any one method.

Posterior Method.—An incision about 5 in. long is made in the line of the right rectus from 1 in. below the margin of the ribs downward. The rectus muscle is divided in the line of its fibers and the posterior sheath in the same line. The peritoneum is divided between forceps. The most dependent portion of the stomach is located and grasped in forceps; the omentum and transverse colon are raised up and folded in a hot pad on the anterior abdominal surface; the ligament of Treitz and the beginning of the jejunum are located. The jejunum is pulled over to the right side until it is put on the stretch. Then the posterior layer of the transverse mesocolon is divided, and the most dependent portion of the stomach drawn through. Doyen's clamps are put on the stomach and bowel. The serous coats are sutured together with a continuous suture; then the stomach and intestine are opened, and a portion of the redundant mucous membrane is cut away. The edges of the stomach and intestinal wounds are sutured together, and the first or serous suture is continued around and tied to the original end, which was left long. The clamps are removed and the abdominal wound is closed.

Instead of the suture, the Murphy button may be used.

Give the symptoms and treatment of ruptured gastric ulcer.

Symptoms.—Sudden and violent epigastric pain and profound collapse. Marked rigidity and tenderness in the upper abdomen. Liver dulness greatly diminished. Vomiting rarely occurs.

Treatment.—Immediate abdominal section with repair of the rupture and the performance of a posterior gastro-enterostomy. Usually the abdomen is drained.

Give the symptoms of cholecystitis.

Temperature, 102° to 103° F., rapid pulse, pain, and tenderness over the tip of the ninth rib. The thighs and knees are drawn up. Nausea and vomiting are frequent. Jaundice is frequently present.

Give the symptoms of gall-stones in the common duct.

Irregular fever, frequently nausea and vomiting, and usually constipation. Jaundice is almost always present. Pain and tenderness present over Mayo Robson's point. When the stone is passing down the duct, or when it passes into the duodenum, paroxysms of acute pain occur.

Give the treatment of stone in the common duct.

Perform an abdominal section and remove the stone by making an opening in the common duct.

Describe the operation of cholecystotomy.

The patient is placed on his back with a sand-pillow under his back. Make an incision through the right rectus and open the peritoneum. The gall-bladder is walled off with pads, aspirated, and then opened. Gall-stones are removed with forceps or scoop or by irrigation. The ducts are examined with the fingers, and sounded if possible. After the removal of all stones and fragments a rubber tube is passed into the gall-bladder, the gall-bladder drawn up around the tube by a purse-string suture, and the bladder sutured to the abdominal aponeurosis. The abdominal pads are removed and the wound sutured around the tube.

Mention the symptoms and signs of acute appendicitis.

The premonitory symptoms are diarrhea, followed by constipation, flatulence, nausea, and colicky pain about the umbilicus.

The acute symptoms and signs are: Temperature, 102° to 103° F., rapid pulse, pain, tenderness and hyperesthesia of the skin in the right iliac fossa. The thighs and knees are partly flexed. Nausea and vomiting are frequently present. Moderate leukocytosis, gradually increasing.

Give the Ochsner treatment of acute appendicitis.

1. In patients seen early, before rupture of appendix, operate at once.

2. If rupture has occurred, absolute starvation; gastric lavage if distention, nausea, or vomiting is present. No cathartics or high enemata should be given. Operate after infected area has been walled off.

Give the differential diagnosis between appendicitis and renal colic.

	Appendicitis	Renal colic
Pain:	Over McBurney's point.	In the groin and testicle.
Tenderness:	Over McBurney's point.	In loin and groin.
Vomiting:	Late.	Early.
Urine:	Clear.	Blood and pus usually present. There may be a history of frequent urination.
X-ray:	No stone.	Stone present.

Describe McBurney's gridiron incision for appendicitis. What is the advantage of this incision and what is the disadvantage?

An oblique incision about 3 in. in length is made, commencing 1 in. above McBurney's line, and crossing this line about 1½ in. inside of the anterior superior spine. The position of the incision will naturally vary somewhat, but it should always be made in the direction of the fibers of the external oblique muscle. The aponeurosis of the external oblique and a small portion of the muscle itself are now divided in the direction of the external incision. The fibers of the external oblique should be separated, great care being taken that none of the fibers are divided transversely. Retractors are now placed in the wound, and the internal oblique and the transversalis muscles are similarly split in the direction of their fibers. The transversalis fascia and peritoneum are then divided in the usual manner.

The advantage of the incision is that the abdominal wall is not weakened as much as if the muscle-fibers were cut across, and there is less tendency to subsequent ventral hernia. The disadvantage of this incision is that the amount of room to work in is somewhat lessened, the performance of the operation being consequently rendered more difficult, and that it gives a poor chance for drainage on account of the contraction of the muscles.

Relate the causes of intestinal obstruction.

Acute Obstruction.—1. Strangulation by bands, adhesions, apertures, or Meckel's diverticulum. 2. Volvulus. 3. Impaction of foreign bodies. 4. Acute intussusception.

Chronic Obstruction.—1. Impaction of feces, gall-stones, and foreign bodies. 2. Intestinal affections, such as stricture, tumors, angulation of gut from contraction of adhesions, and matting together of intestinal coils. 3. Compression of the intestines by tumors or exudates outside of the bowel.

Define volvulus and give its treatment.

Volvulus, or the twisting of a loop of intestine around its axis, constitutes a well-defined form of intestinal obstruction. This pathologic condition can occur only where the mesentery of the bowel is of considerable length, and is, therefore, most frequently met with in the lower portion of the ileum and at the sigmoid flexure of the colon. The immediate cause of the volvulus has been ascribed to the accumulation of intestinal contents above a constricted portion of bowel, and in a few cases to adhesions between an omental stump and an intestinal loop.

Treatment.—Celiotomy immediately on making the diagnosis. An

attempt should be made to untwist the intestine; if successful, the mesentery should be shortened to prevent a recurrence. If impossible to untwist, resect the twisted portion and do a circular enterorrhaphy. If the patient is in bad condition and a large amount of large intestine is involved, perform colostomy.

Enumerate the diagnostic points in intussusception.

Colicky abdominal pain, vomiting, tenesmus, the passage of blood-stained mucus or pure blood, and the presence of a sausage-shaped tumor, which usually is situated in the line of the colon. In advanced cases rectal examination may reveal the presence of the intussusceptum. Acute intussusception is more common in early childhood; chronic intussusception is more frequently observed in adults.

Describe the steps in the operation of inguinal colostomy.

An incision about 2 in. in length is to be made, $1\frac{1}{2}$ in. above and parallel with the outer portion of Poupart's ligament. This incision should be carried down to the peritoneum. All hemorrhage having been stopped, the parietal peritoneum is to be incised for about two-thirds of the length of the external wound. After the colon has been found, it should be drawn out of the wound, pulled from above downward, returning the protruding bowel through the lower angle as it is drawn out from the upper one. As soon as the colon is almost taut, an opening is made in the mesosigmoid and a glass rod passed through it so as to bring a coil of intestine out of the wound; the ends of the rod rest upon the skin. The two limbs of the intestinal coil are fixed by suturing them together beneath the glass rod. Stitch the serous coat of the bowel to the parietal peritoneum. Apply an aseptic dressing and, whenever possible, wait from twenty-four to forty-eight hours before opening. The colon is opened with the cautery or scissors. If the artificial anus is to be permanent, make a transverse incision through the bowel. Cut one-fourth the way through the colon when it is first opened, and entirely across at a later period. If the artificial anus is to be temporary, the incision is longitudinal.

How would you proceed surgically to remove the fluid in a case of ascites?

The patient should be propped up on an operating table, the bladder emptied by catheterization, and the lower abdomen sterilized; a point about 4 in. above the pubes is anesthetized by a local method. A trocar and cannula, guarded by the thumb, should be plunged in at that point; almost all the fluid should be removed, the cannula withdrawn, and the puncture closed with gauze and collodion.

HERNIAS

Describe the anatomic varieties of abdominal hernia.

Oblique or External Inguinal.—The hernia enters the inguinal canal through the internal abdominal ring, external to the deep epigastric artery. This variety is called complete if it escapes through the external abdominal ring (scrotal hernia in the male, labial in the female); it is called incomplete (bubonocele) if it remains in the inguinal canal.

Direct or Internal Inguinal.—The hernia gains entrance to the inguinal canal by passing through Hesselbach's triangle. It does not pass through the internal abdominal ring; the neck of the hernia is internal to the deep epigastric artery.

Femoral.—The hernia passes out of the abdominal cavity through the femoral canal, and makes its appearance upon the thigh through the saphenous opening.

Umbilical.—The hernia passes through the umbilical ring.

Obturator.—The hernia passes out of the abdominal cavity through the obturator canal and may make its appearance upon the inner surface of the thigh.

Sciatic.—The hernia passes out of the pelvis through one of the sacro-sciatic foramina, usually the greater, and makes its appearance at the lower border of the gluteus maximus.

Perineal.—All hernias which protrude through the muscular floor of the pelvis toward the perineum are termed perineal hernias.

Diaphragmatic.—The hernia protrudes through the diaphragm.

Ventral.—The hernia appears at any portion of the anterior abdominal wall except the umbilicus.

Lumbar.—A hernia making its appearance in the lumbar region.

Internal Hernias.—Hernia through the foramen of Winslow. Hernia through the duodeno-jejunal fossa. Hernia through the retro-cecal and ileo-cecal recesses. Hernia through the inter-sigmoid recess.

What are the predisposing and what are the exciting causes of abdominal hernia?

Predisposing Causes.—Early life, male sex, occupations demanding great muscular exertion, structural defects (elongation of the mesentery, patent funicular process), heredity, phimosis, pertussis, bronchitis, urethral stricture, constipation, weakening of the abdominal wall by injury, operation, and pregnancy.

Exciting Cause.—Any increase of the intra-abdominal pressure.

What is the cause of the impulse felt in a scrotal hernia on coughing? When is this impulse absent in such a hernia, and in what other condition resembling hernia may it be present?

In a scrotal hernia the cavity is connected with the abdominal cavity, and any increase in the intra-abdominal pressure will, of course, be transmitted to the hernial sac. This impulse is absent when strangulation is present. An impulse may be present in a congenital hydrocele.

Describe (a) complete indirect inguinal hernia, (b) the symptoms of strangulation, (c) methods of reduction, and (d) operation if strangulation exists.

(a) In complete inguinal hernia the sac extends down in the scrotum in the male, in the labia majora in the female. It passes out through the internal abdominal ring into the inguinal canal, then through the external ring into the scrotum or labia.

(b) When strangulation begins, the patient is seized with pain about the hernial orifice and with violent colicky pain; the paroxysms of colic

become more and more frequent, until finally the pain may be continuous. The hernia is found to be irreducible, larger than usual, tender, painful, dull on percussion, without an impulse on coughing. Eructations of gas are frequent, and generally uncontrollable vomiting and prostration come on. Constipation is absolute, no gas even being passed. When gangrene begins, the symptoms apparently lessen in violence.

(c) Grasp the hernia in the palm of the hand, and with the other hand assist the part that came out last to enter first, and so on until all the hernia is reduced.

(d) Perform the radical operation if the patient's condition will warrant it. If not, divide the constriction, examine the gut, resect it if necessary, or suture it in the wound and at a later date do a radical operation.

What tissues are divided in the operation for oblique inguinal hernia?

Skin, superficial and deep fascia, external and internal oblique muscles, coverings of the sac (intercolumnar fascia, cremasteric fascia, infundibuliform fascia, subserous areolar tissue, and peritoneum).

Describe Bassini's operation for the radical cure of oblique inguinal hernia.

An incision is made parallel to Poupart's ligament, extending from the external ring to a point on the abdominal wall opposite the internal ring. The incision is about 1 in. above the ligament and about 5 in. in length. By this incision the aponeurosis of the external oblique and the pillars of the external ring are exposed. All bleeding is arrested, the aponeurosis is incised in the direction of its fibers, from above downward, and the inguinal canal is opened. The aponeurosis of the external oblique is dissected up until Poupart's ligament is exposed. A mass containing the sac of the hernia, the cord, the cremaster muscle, and considerable fat is lifted up. Masses of fat, portions of spermatic veins, and usually the cremaster muscle are removed. The sac is isolated first at its neck; the neck is stripped from the inner aspect of the internal ring for the distance of $\frac{4}{5}$ in. The sac is opened at the fundus, the interior is investigated, and if the contents are reducible, they are restored to the abdominal cavity and the neck of the sac clamped high up. Tie off the neck of the sac above the clamp. High removal obviates the leaving of a funnel-shaped depression of peritoneum. The cord is now lifted out of the way, the inner surface of Poupart's ligament is exposed by retraction, and the deep sutures are passed, uniting the conjoined tendon and the internal oblique muscle to the deep, shelving edge of Poupart's ligament. The sutures are tied from above downward. The cord is laid upon this new floor, and the aponeurosis of the external oblique is sutured over it. Most American operators use kangaroo tendon or chromicized catgut for sutures.

What structures are divided in the operation for strangulated femoral hernia?

Skin, superficial fascia, cribriform fascia, femoral sheath, septum crurale, subserous areolar tissue, peritoneum, and the constriction, which is usually the edge of Gimbernat's ligament.

Outline the treatment for irreducible umbilical hernia.

Wash out the patient's stomach, etherize, and perform the operation for radical cure, being careful to examine well the gut; resect the gut if necessary.

Describe the operation for the radical cure of umbilical hernia.

Mayo's Operation.—Transverse elliptic incisions are made around the umbilicus and hernia, and the base of the protrusion is exposed. The surface of the aponeurosis is cleared for $1\frac{1}{2}$ in. around the neck of the sac. The fibrous and peritoneal coverings of the hernia are divided by a circular incision around the neck of the sac. The intestines are freed from the adhesions and laced within the abdomen. The omentum is ligated and removed with the sac. The margins of the ring are grasped and overlapped in order to indicate in which way it can be most easily done. An incision is made through the fibrous and peritoneal coverings of the ring, 1 in. or more transversely on each side, and the peritoneum is stripped from the under surface of the upper flap. Several mattress sutures are introduced 1 in. above the edge of the upper flap and carried through the margin of the lower flap; sufficient traction is made to permit of the closing of the peritoneum with a continuous catgut suture. When this has been accomplished, the mattress sutures are drawn so as to slide the lower flap into the pocket between the peritoneum and the under surface of the upper flap. The free margin of the upper flap is fixed by catgut sutures to the aponeurosis, and the skin wound is closed in the usual manner.

TUMORS

What is a tumor?

A tumor is a pathologic new-growth which tends to persist independently of the structures in which it lies, and which performs no physiologic function and has no known cause.

Name the different varieties of malignant tumors.

Sarcoma (round, spindle, giant-cell, melanotic, alveolar), lymphosarcoma, endothelioma, carcinoma (epithelioma; scirrhous, encephaloid, melanotic, and colloid cancer).

Name the different varieties of benign tumors.

Lipoma, fibroma, chondroma, osteoma, myxoma, angioma, lymphangioma, myoma, neuroma, adenoma, and papilloma.

Mention the general characteristics of a benign tumor, as distinguished from a malignant tumor.

Benign tumors, in contradistinction to malignant tumors, are usually encapsulated, grow slowly, do not infiltrate, are not painful, do not give metastasis, do not recur after removal, produce no cachexia.

Through what channels is carcinoma disseminated?

Through the lymphatic and blood-channels.

When is operative interference advisable in the treatment of malignant tumors?

Operative interference is advisable when the growth can be thoroughly removed, when the operation will diminish the pain or make the patient more comfortable, and when it will lengthen life.

What general principles govern the diagnosis of a tumor?

Age, sex, hereditary influence, previous history, the location, shape, size, consistency, and rapidity of the growth of the tumor, movability of the tumor, whether it has given rise to metastases, whether the neighboring glands are involved, and the presence or absence of cachexia.

What is an adenoma?

Adenomata are tumors corresponding in structure to normal epithelial glands. They may contain acini and ducts, like racemose glands, or tubes, like tubular glands. Unlike normal glands, these tumors have no secretory ducts and no physiologic function.

What are angiomata?

An angioma is a tumor composed largely of dilated blood-vessels. Some of the so-called angiomata are not genuine new-growths, but are due to dilatation and elongation of blood-vessels.

Describe a chondroma. Where are such growths most commonly found?

Chondromata are tumors formed either of hyaline cartilage or of fibrocartilage, or of both. They may be single or multiple, and are most commonly seen in the young.

Seats of Predilection.—The bones, especially on or in the phalanges, the lower epiphyseal region of the femur, the upper ends of the tibia, fibula, and humerus, the scapula, the ilium, the jaws, especially the upper, the salivary glands (notably the parotid), and the testicle.

What are gliomata and where are they found?

A glioma consists of cells containing round or oval nuclei with very little protoplasm, and fine protoplasmic extensions which interlace and form an intercellular reticulum. These tumors develop from neuroglia, and more often from the white substance than from the gray. They are usually single and arise in the brain, rarely in the cord, and very rarely in the cranial nerves.

Describe dermoid cysts. In what situations are they most commonly found?

A dermoid is a heterotopic cyst, the wall of which is composed of connective tissue lined with epithelium. The cysts contain material formed by the proliferation of the epithelium, and frequently hair, teeth, or even bone. Dermoid cysts are most commonly found in the ovary and in regions where, during bodily development, the blastodermic layers come in contact; for instance, in the neck, the eyelids, the orbital angles, the region of the coccyx, the root of the nose, and the floor of the mouth.

What is an epulis?

This is a term which is applied to various tumors of the gums. They are really not connected with the gums at all, but with the periosteum of the alveolar process and sockets of the teeth. Two forms are usually described: simple or fibrous, and malignant or myeloid epulis.

Give the indications for the removal of the mammary gland.

Carcinoma, sarcoma, diffuse hypertrophy, diffuse septic or tuberculous disease, certain cases of interstitial mastitis, and Paget's disease of the nipple.

Give the treatment of mammary carcinoma.

Removal of breast and axillary glands with sternal head of the pectoralis major and the pectoralis minor muscles, known as Halsted's operation. After the wound is healed, about ten treatments with the *x*-ray should be given.

What is Paget's disease of the nipple? State the special significance of its occurrence.

This condition is a chronic inflammation of the epithelial layer of the nipple and areola, occurring in woman beyond middle life. It is usually a precursor of epithelioma of the nipple and of duct cancer.

Describe teratomata and give their situations.

A teratoma is a tumor composed of various tissues, organs, or systems of organs which do not normally exist at the place where the tumor grows. All teratoid tumors are congenital; that is, the tumor either exists at the time of birth or the patient is born with the essential tumor matrix. In the simpler varieties the tumor is composed of heterotopic tissues, such as bone, teeth, skin, mucous membrane, etc. The members of this group most often seen by the surgeon are branchial cysts and dermoid cysts.

GENITO-URINARY SURGERY

Name five of the principal complications of gonorrheal urethritis in the male.

Cystitis, prostatitis, epididymitis, lymphangitis, and bubo.

In what portion of the male urethra are gonorrheal strictures most common?

In the penile portion.

Differentially diagnose phimosis and gonorrhea from phimosis and sub-preputial chancroid.

In phimosis and gonorrhea there is no history of a sore on the glans or prepuce; the preputial swelling is at first simply edematous; the discharge is usually purulent; there is no localized area of hardness or tenderness; chordee is frequently present; the ardor urinæ is felt along the entire urethra; vesical symptoms are common, bubo less frequent than in chancroid, and the gonococci are found in the discharge.

In phimosis and sub-preputial chancroid there is a history of a sore; the preputial swelling is due to a localized area of hardness; tenderness is usually present; true chordee never occurs; the ardor urinæ is experienced only when the urine comes in contact with the ulcerated foreskin; vesical symptoms are absent, and bubo is very common.

Describe a chancroid. Give its usual symptoms and possible complications.

Chancroid is a localized ulceration, caused by contact with the secretions of a similar ulcer. The bacillus of Ducrey is found in the secretion. The characteristics are: a short period of incubation—three to five days; it is usually multiple and inflammatory in type, with punched-out edges and abundant discharge. It is auto-inoculable, but is not followed by any constitutional symptoms. It starts as a papule, becomes a vesicle, followed very shortly by a pustule, then an ulcer. The complications are: bubo, phimosis, paraphimosis, and phagedenic and serpiginous ulceration.

Differentially diagnose chancre, chancroid, and herpes progenitalis.

Chancre.	*Chancroid.*	*Herpes.*
Origin: Due to inoculation with the discharges of the first and second stages of a syphilitic lesion.	Due to inoculation with the discharge of a chancroidal sore. Bacillus of Ducrey.	(1) Mechanical irritation, as in sexual intercourse. (2) Chemical irritation, such as is produced by acid discharges or by uncleanliness. (3) Neurosis, often following fever.
Incubation: From ten days to eight weeks. Average about three weeks.	No definite period. Usually two or three days.	None.
Number: Single, at times simultaneously multiple.	Frequently multiple, often on opposing surfaces by auto-inoculation.	Multiple. Ulimately often confluent.
Beginning: Begins as an erosion, papule, tubercle, or ulcer. May remain without ulceration through its entire course.	Begins as a pustule or an ulcer. Always ulcerates.	Begins as a group of vesicles, which may coalesce or may ulcerate singly.
Depth: Usually superficial, saucer-shaped.	Hollow, excavated, or "punched out."	Superficial.
Secretion: Scanty serous, never auto-inoculable.	Abundant, purulent, readily auto-inoculable.	Moderate; several drops can be squeezed out. Usually does not auto-inoculate.
Induration: Almost always present, firm, parchment-like, sharply circumscribed.	Only exceptionally present. Is not sharply circumscribed.	Usually not present.
Sensibility: Very rarely painful.	Often painful.	Often painful.
Course: Progressively toward a cure, often healing spontaneously. Relapses and phagedena do not occur.	Irregular; may cicatrize rapidly or may extend. Relapses and phagedena not uncommon.	Easily and quickly cured. Sometimes spreads by the appearance of successive crops of vesicles; also recurs in unclean persons with long foreskins.
Inguinal adenitis: Constant, painless, multiple, generally bilateral; glands usually do not break down.	Very frequent, painful, unilateral, inflammatory; an abscess is usually formed.	Very rare; when present, usually unilateral.
Prognosis: Good locally, usually does not leave a scar.	More serious locally, usually scars, at times becomes phagedenic.	Always good. Recurrences are frequent; leaves no scar.

When do the secondary symptoms of syphilis normally appear? What are these symptoms? When do the tertiary symptoms appear?

(a) On an average, about six weeks after the chancre appears.

(b) The *secondary symptoms* are: 1. Alterations of the blood. Diminution in the hemoglobin percentage, diminished number of red corpuscles, slight increase in the number of white corpuscles. 2. General lymphatic enlargement. 3. Moderate fever, reaching 100° to 101° F. in the evening. 4. Muscular and articular pains, usually moderate in severity. 5. Alopecia, involving the hairy surfaces of the entire body, and causing ragged and irregular bald spots. 6. Eruptions of the skin and mucous membranes.

(c) The *tertiary symptoms* usually appear about two years after the appearance of the chancre. At times they may appear after six months, or again not for years, when the patient has had partial treatment.

What are the chief affections of the scrotum?

Eczema, erysipelas, ecchymosis, hematoma, chancre, chancroid, epithelioma, mucous patches, elephantiasis, and gangrene.

What are the chief surgical diseases of the groin?

Inguinal hernia, femoral hernia, lymphadenitis, encysted hydrocele of the cord, tumors of the round ligament, and psoas abscess.

Give the local treatment of venereal bubo.

Gonorrheal and chancroidal buboes may sometimes be aborted by the use of pressure and iodin, or by a puncture and injection of iodoform ointment. If the gland suppurates, it should be incised under antiseptic precautions, cureted, and treated like any abscess. If the suppuration is encapsulated, the entire mass should be dissected out and the wound closed by primary suture.

Describe hypospadias, epispadias, phimosis, and paraphimosis.

Hypospadias is a malformation in which the urethra opens upon the under surface of the penis. Epispadias is a malformation in which the urethra is partially or wholly exposed on the upper surface of the penis. Phimosis is that condition in which the preputial orifice is so narrow that it cannot be retracted behind the corona. By paraphimosis is meant a strangulation of the glans penis by a prepuce which has been forcibly retracted and cannot be replaced.

What are the causes and treatment of paraphimosis?

Causes.—Edema following upon the retraction of a tight prepuce and violent coitus.

Treatment.—The glans should be rendered bloodless by digital pressure. The index and middle fingers of each hand are now crossed behind the glans, and an attempt made to force the glans through the constricted preputial orifice by pressing upon it with the thumbs. If the edema of the prepuce is very marked, it may be punctured in several places to relieve tension. Should this measure fail, the preputial orifice (at the bottom of the second groove) is to be divided with a sharp-pointed curved bistoury.

Describe the varieties of hydrocele.

- I. Hydrocele of the testis.
  - (a) *Hydrocele of tunica vaginalis.*— The fluid is in a sac connected with that of the tunica vaginalis.
    1. *Ordinary Hydrocele.*—The fluid distends the closed sac of the tunica vaginalis.
    2. *Congenital Hydrocele.*—A communication exists between the cavity of the tunica vaginalis and that of the peritoneum.
    3. *Infantile Hydrocele.*—The tunica vaginalis and the funicular process are distended with fluid, but these are shut off from the peritoneal cavity by an obliteration placed usually at the external ring.
    4. *Inguinal Hydrocele.*—Hydrocele in relation with a retained testis.
  - (b) *Encysted Hydrocele.*—The fluid is in a sac distinct from that of the tunica vaginalis.
    1. *Encysted Hydrocele of Epididymis.*—The fluid is encysted in the neighborhood of the epididymis.
    2. *Encysted Hydrocele of the Testis.*—The fluid is encysted between the tunica albuginea and the inner surface of the tunica vaginalis.
- II. Hydrocele of the cord.
  - (a) *Diffuse.*—The fluid forms a serous collection of the nature of edema in the cellular tissue of the cord.
  - (b) *Encysted.*—The fluid is contained in a distinct sac originating usually (1) in some unobliterated part of the processus funiculo-vaginalis; (2) in a cyst formed independently of this process, by dilatation of persistent tubules of the organ of Giraldès.
- III. Hydrocele of the sac of a hernia.

Give the palliative and the operative treatment of hydrocele.

Palliative Treatment.—Tapping.

Operative—Doyen's Method.—Carefully free the hydrocele and deliver it from the scrotum, then incise it and reverse it over the testicle and suture it there, in that way obliterating the cavity; or the skin and hydrocele may be incised together, the edges of the hydrocele and skin sutured together, and the cavity obliterated by packing with gauze.

Give the course, symptoms, and treatment of varicocele.

Course.—It is an affection of early adult life, more common in the unmarried. The veins gradually increase in size if not supported by a suspensory or operated upon.

Symptoms.—Dragging sensation in the scrotum, swelling is felt along the spermatic cord, resembling a bunch of earth-worms; it does not give an impulse on coughing. Almost always situated on the left side.

Treatment.—Palliative; suspensory bandage. Operative: incise the tissues over the cord as it passes into the external abdominal ring; separate the veins from the vas deferens; apply a double ligature 1 in. apart; cut out intervening veins and suture stumps together with fine catgut; close the wound without drainage. Wear a suspensory bandage for two weeks.

What are the indications for castration?

Malignant and non-malignant tumors and tuberculosis of the testicle; also certain forms of malposition.

What are the causes of acute prostatitis? Describe a typical case of acute prostatitis and give the treatment.

Causes.—Urethritis (usually gonorrheal), traumatism, stricture, retention of urine, prostatic calculi, and cystitis.

Symptoms.—Deep-seated pain, accompanied by a sensation of heat and weight in the perineum. The desire to pass water is frequent, and micturition is painful, particularly at the conclusion of the act. Defecation is painful, and digital examination per rectum reveals a hot and exquisitely tender swelling of the prostate gland. Usually a muco-purulent discharge can be obtained from the urethra by massage of the prostate. The perineum is hot and tender. The patient cannot sit comfortably, and supports his weight upon one buttock to avoid pressure upon the perineum. If suppuration occurs, as is usually the case, the pain becomes more marked and of a throbbing character, the perineum becomes red and edematous, retention of urine may occur, and the passage of a catheter causes excruciating pain; fever is present, and there may be a marked chill. The abscess may discharge through the urethra, rectum, or perineum.

Treatment.—Absolute rest in bed and liquid diet. The bowels should be kept loose to avoid the pressure of hardened feces upon the inflamed prostate. Hot hip-baths sometimes cause a marked diminution of the pain. If the case is seen early, leeches followed by hot fomentations applied to the perineum. If the pain is intense, suppositories of morphin and belladonna should be given. If retention is present, the urine should be drawn off with a small rubber catheter. If suppuration has occurred, the passage of the catheter will occasionally rupture the abscess, which may then evacate itself through the urethra. If this does not occur, and there are evidences of deep-seated suppuration, or if the pus does not discharge freely, the patient should be etherized and placed in the lithotomy position. The finger is now introduced into the rectum, and an incision made in the median line of the perineum down to the seat of pus-formation. The abscess cavity is then evacuated and irrigated, and a drainage-tube introduced.

Give the symptoms and treatment of hypertrophy of the prostate gland.

Symptoms.—In 90 per cent. of the cases there is very little inconvenience, the patient merely being annoyed somewhat by episodes of nocturnal frequency of micturition. The stream is slow to start and falls feebly from the end of the penis. The last drops fall entirely without control.

In 10 per cent. of all cases the bladder cannot be entirely emptied, and residual urine collects. Frequency of micturition comes on, particularly at night; the patient has to get up often; the bladder never feels empty, and cystitis is apt to arise. The urine, at first acid and clear, becomes neutral and cloudy, and finally ammoniacal and turbid; it contains bacteria, muco-pus, precipitates of phosphates, and blood. Enlargement of the lateral lobes can be detected by a finger in the rectum. A patient should be examined by rectal touch, by a sound, and with a cystoscope. The amount of residual urine must be determined and the condition of the urine carefully studied.

Treatment.—Consists of non-operative and operative measures. The *non-operative* consists in regular and cleanly catheterization and a careful adherence to hygienic rules. Have the patient use a soft-rubber or a woven catheter, never a metallic one. If there are 3 oz. of residual urine, use the catheter at night only. If 6 oz., use it night and morning. If there are more than 6 oz. of residual urine, add one more catheterization a day for every additional 2 oz. present until the catheter is used six times in the twenty-four hours. The urine should be kept acid by the use of salol, 5 gr., four times a day. The *operative* treatment consists in the Bottini operation, which consists in dividing the neck of the bladder in several directions through the urethra with an electric cautery.

Suprapubic and Perineal Prostatectomy.—The suprapubic method is the same as suprapubic cystotomy until the bladder is opened; after that the prostate is enucleated with the fingers and the bladder drained through the wound and through the urethra.

Describe the operation of perineal prostatectomy.

The bladder is irrigated and filled with warm salt solution. A grooved staff is introduced, and a median perineal section is made to open the urethra just in front of the apex of the prostate gland. The knife is pushed back in the groove of the staff sufficiently far to incise the ring at the apex of the prostate; the forefinger is passed into the prostatic urethra and the staff withdrawn. Then a short tear is made into the mass of the left lobe, the finger introduced, and the lobe enucleated. The same procedure is carried out on the right lobe, and finally, if necessary, on the middle lobe. A large perineal tube is introduced and bleeding is arrested by packing.

Define nephrorrhaphy, nephrotomy, and nephrectomy. Give an indication for the performance of each.

By *nephrorrhaphy* is meant the stitching of a kidney to the posterior wall of the abdomen. Indication, floating kidney. By *nephrotomy* is meant the cutting into a kidney. Indication, renal calculus. By *nephrectomy* is meant the excision of a kidney. Indication, a primary malignant renal growth.

What conditions of the kidneys require nephrectomy?

Any of the following conditions may require nephrectomy: Carcinoma, sarcoma, tuberculosis, calculous pyonephrosis, and hydronephrosis.

Describe the operation of nephrectomy.

Description of Operation.—The patient is placed on the sound side, and a pillow is placed under the loin. An incision is made extending from the last rib to just above the crest of the ilium, ½ in. outside of the erector spinæ. This incision extends down through the lumbar fascia. After exposure, deliver the kidney through the wound and separate it from the peritoneum; pass a threaded aneurysm needle between the vessels; cut the ligature near the eye, leaving two ligatures; ligate each half, and tie complete stump with the last ligature, after it has tied one-half of the vessels. If the ureter is healthy, ligate and drop it back; if it is diseased, resect it after removing the kidney. Stop the hemorrhage and suture the wound.

Give diagnosis and treatment of floating kidney.

There may be no discomfort whatever or the patient may be a confirmed invalid. The usual symptoms are epigastric pain, which disappears when the kidney is replaced, dragging pain in the loin, and paroxysms like nephritic colic. Sudden attacks of violent pain in the kidney or stomach may occur, attacks which are accompanied by nausea, vomiting, great weakness or collapse, vertigo, chills, and subsequently elevated temperature (Dietl's crises). Dietl's crises are due to kinking or twisting of the ureter or renal vessels. Usually, in a case of movable kidney, there is a sense of a moving body in the abdomen, and the patient has aggravated indigestion, often accompanied by vomiting. Constipation is the rule, and violent attacks of cardiac palpitation are common. All the symptoms are intensified by exertion and modified by rest. The urine is normal, except after violent exercise, when it may contain blood. The proof of the existence of a floating kidney is the finding of a tumor shaped like a kidney (movable on respiration, change of position, and palpation). Pressure upon a movable kidney usually occasions no sensation.

Treatment.—1. Mechanical support by a special corset, applied while the patient is lying down, with the buttocks higher than the shoulders. 2. Nephrorrhaphy (nephropexy).

Give symptoms of stone in the kidney and treatment of same.

The patient usually complains of pain in the loin, and sometimes of pain in the iliac fossa. Deep percussion over the kidney causes pain in the loin. Pain is aggravated by exercise. The urine often contains albumen, and may from time to time contain blood. Frequent micturition is noted during the day, but not at night. The urine may be purulent. Nephritic colic is due to the washing of a calculus into the orifice of the ureter. If in doubt, catheterize the ureters and examine the fluid. Have a skiagraph taken. When the stone is impacted in the pelvis, the point of greatest tenderness on pressure is below the last rib, by the edge of the erector spinæ muscle.

Treatment.—For gravel of the uric-acid diathesis use alkalies, especially the liquor potassii citratis, and reduce the amount of nitrogen in the diet, at the same time washing out the organs by copious draughts of lithia water. Piperazin, in doses of 5 gr. three times a day, is highly commended. Exercise is to be insisted on. When the gravel is phosphatic, order strych-

nin, mineral acids, and rest. When oxalate of lime is found, restrict the diet, use the mineral acid, and give an occasional course of sodium phosphate. Nephritic colic is relieved by hypodermic injections of morphin and atropin, hot bath, diluent drinks, or the inhalation of ether. If the stone is impacted in the ureter, perform the operation of ureterolithotomy. If the symptoms point to stone in the kidney, medical treatment having been used without avail, operate. Make a lumbar incision, feel the surface of the kidney with the finger, sound the inside of the organ with a needle, and if a stone is detected, incise the kidney and remove the stone.

State how to proceed to diagnose a suspected rupture of the urinary bladder.

Catheterize the bladder, when, usually, a little bloody urine will be obtained; the catheter occasionally slips through the tear into the peritoneal cavity. A measured amount of boric-acid solution is injected, and it is improbable that all of it will be withdrawn. The injection fails to lift the bladder into the hypogastric region so as to be recognizable on percussion. In doubtful cases pump air or hydrogen into the bladder. An unruptured bladder will rise above the pubes as a pyriform tumor, tympanitic on percussion. A ruptured bladder will not do so. In intraperitoneal rupture the air will pass into the peritoneal cavity and distention will occur. In extraperitoneal rupture injection will produce emphysema of the extravesical connective tissues. On removing the syringe the air rushes out again if the bladder is unruptured; but little, if any, comes away if it is ruptured. If still in doubt, make a suprapubic incision and inspect the prevesical space for signs of rupture. If extraperitoneal rupture is not found, open the peritoneal cavity and explore.

Give the causes and treatment of rupture of the urinary bladder.

Predisposing causes: distention of the bladder, ulceration, degeneration, or atony of the bladder coats.

Exciting causes: obstruction to outflow of the urine (by stricture or enlarged prostate), external violence, falls upon the feet and the buttocks, as well as upon the abdomen, lifting, straining at stool, during micturition or parturition, and forcible injection of the bladder.

Treatment.—In extraperitoneal rupture, after incision down to the bladder, insert a drainage-tube. In intraperitoneal rupture place the patient in the Trendelenburg position, expose the bladder, and suture the opening in the bladder.

What are the causes of atony of the bladder?

Senility, distention from paralysis, chronic overdistention from obstruction, and acute overdistention.

Describe the surgical treatment for retention of urine.

In retention due to organic stricture try to pass a woven catheter; if not successful, make an attempt to pass a filiform into the bladder; if successful, it may be left in place for twenty-four hours, as it will act as

a capillary drain, or a Gouley's tunneled catheter can be threaded upon it and passed into the bladder. In prostatic cases a Mercier's double-elbowed woven catheter may be tried, or a metal instrument with a very large curve. If unable to pass any instrument, aspirate, and in a few hours, when the swelling and congestion have decreased, an instrument can be passed. In place of aspiration a perineal section may be performed.

Name the principal operations for stone in the bladder.

Perineal lithotomy, suprapubic lithotomy, and litholapaxy.

Describe suprapubic lithotomy.

Place the patient in the Trendelenburg position. It is necessary to distend the bladder and raise it in order to have the prevesical space uncovered by peritoneum. Have an assistant oil the rectal bag and push it above the sphincters. Draw off the urine with a soft catheter, wash out the bladder with warm boric-acid solution, and inject the bladder with the same solution. In a child under the age of five, inject 3 to 4 oz.; in an adult, inject 10 to 12 oz. Withdraw the catheter and tie a tube around the penis to prevent the escape of fluid; if the viscus is not well lifted, inject the rectal bag with water and clamp its tube. In a child, inject from 2 to 4 oz. of warm water into the rectal bag; in an adult, inject 10 oz. Air may be injected into the bladder in place of water. If air is injected, a rectal bag is not used, and the patient is placed in the normal position. Make a 3 in. longitudinal incision in the median line of the hypogastric region, terminating over the symphysis. When the prevesical connective tissue is reached, cut it; if the peritoneum should appear, push it up. Hold the edges of the wound apart with retractors. Catch the bladder transversely with a tenaculum at the upper angle of the wound. Take off the tube around the penis and press out the solution; then cut the bladder in the middle line and grasp the edges with hemostatic forceps and remove the tenaculum. Explore the bladder, remove the stones, scrape away incrustations, and irrigate the viscus with hot saline solution. If suprapubic drainage is required, introduce a tube in the bladder and suture it to the edge of the skin; attach to its external end a long tube connected to a siphonage apparatus. Suture the bladder, muscles, and skin around tube. If suprapubic drainage is not required, suture the bladder, then the muscles and skin. Drain the bladder by means of a catheter.

What are the indications for litholapaxy as compared with (a) lateral perineal lithotomy; (b) median perineal lithotomy; and (c) suprapubic lithotomy?

Unless some contraindication exists, litholapaxy is the operation of choice. The contraindications are: (1) Encysted calculus (absolute); (2) a stone larger than $1\frac{1}{2}$ in. in diameter, though many surgeons will crush larger stones; (3) stones consisting of calcium oxalate, which are so hard that the crushing is difficult and sometimes impossible; (4) urethral stricture of old standing, not capable of dilatation, or the existence of false passages; (5) enlarged prostate; (6) sacculated or contracted bladder. Lateral perineal lithotomy is rarely performed at present; median lithotomy

is performed when drainage is desired, as in marked cystitis, contracted bladder, and stricture of the deep urethra. Suprapubic lithotomy is to be performed: (1) When the stone is too large to crush; (2) if the stone is encysted; (3) in the presence of old strictures or an enlarged prostate; (4) when the crushing operation is not deemed advisable in young boys. The indications for the suprapubic operation have been greatly extended in recent years at the expense of the perineal method. The only two absolute contraindications to the procedure are severe septic cystitis and contraction of the bladder.

Give the diagnosis of stone in the bladder.

A patient with stone in the bladder complains of frequency of micturition, particularly in the daytime. Pain of a sharp, burning character is experienced at the end of micturition. To prove the presence of a stone it must be touched with a sound and the contact must be felt and heard, or the stone must be seen by cystoscopic examination, or detected by the *x*-rays.

Give the diagnosis and treatment of complete rupture of the membranous urethra.

The symptoms of rupture of the urethra are considerable pain, aggravated by motion, pressure, and attempts to pass urine. In some cases micturition is still possible. If so, blood precedes and also discolors the urine. The presence of a large swelling is regarded as evidence of urethral rupture. In rupture of the membranous urethra, if uncomplicated, the urine remains between the two layers of the triangular ligament until this space is filled, and then passes up on the anterior abdominal wall.

Describe an operation for circumcision.

The prepuce is drawn forward and grasped by phimosis forceps just in front of the glans. The portion of the prepuce in front of the clamp is then cut off with a sharp bistoury and the clamp removed. It will be observed that the skin has been removed, but the mucous surface of the prepuce still covers the glans. A grooved director is now introduced into the preputial orifice and the mucous layer divided down to its attachment to the corona. All adhesions between the prepuce and the glans must be thoroughly broken up. The entire mucous surface of the prepuce is to be trimmed away to within $\frac{1}{8}$ in. of its attachment to the corona. Special attention should be given to the removal of sufficient tissue from the under side of the penis in order to avoid an unsightly projection in the neighborhood of the frenum. Hemorrhage should now be controlled, and the edges of the mucous membrane and skin sutured together with fine catgut. Cover the wound with an antiseptic dressing.

What affections occur in the female external genitalia?

Vulvitis, vulvovaginal abscess, vulvovaginal cyst, hematoma of the vulva, pruritus vulvæ, hypertrophy of the clitoris, urethral caruncle, noma pudendi, chancre, chancroid, mucous patches, venereal warts, papilloma, and epithelioma.

What is the usual site of a vulvovaginal abscess? Give the symptoms and treatment.

The glands of Bartholin.

Symptoms.—Heat, redness, and tenderness, together with a peculiar pyriform swelling. In the early stages this swelling is best detected by introducing the finger in the vagina and pressing outward.

Treatment.—Incision and drainage. The wound should be irrigated and packed with iodoform gauze. The wound should be dressed daily until healed.

Give the causes, symptoms, and treatment of acute vaginitis.

Causes.—1. Gonorrheal, caused by the gonococcus of Neisser. 2. Erysipelatous, caused by the streptococcus. 3. Diphtheric, caused by the Klebs-Löffler bacillus. 4. Tuberculous, caused by the tubercle bacillus. 5. Mycotic, caused by the leptothrix and oïdium albicans. 6. Chancroidal, caused by Ducrey's bacillus.

The *symptom-group* comprises irritation, pain, redness, swelling, heat, and muco-purulent discharge. Inspection shows congestion and usually excoriations of the vaginal mucous membrane.

Treatment.—Rest in bed, saline cathartics. The vagina should be copiously douched twice daily with boric acid (1 dr. to a quart of water). As soon as the acute symptoms have subsided, the walls of the vagina should be separated by a fold of lint soaked in oxid of zinc cream. This lint should be carried well up into the posterior fornix, allowed to protrude at the vulva, and changed every twenty-four hours. After the disease has subsided the parts should still be douched occasionally to prevent recurrence. In gonorrheal vaginitis the vagina should be washed out every two or three hours, first with a pint or two of an alkaline solution, then with a pint of plain water, and then with a pint of a medicated solution (acetate of lead, acetate of zinc, protargol, argyrol, alum, or tannin).

RECTAL SURGERY

Name the most common varieties of fistula.

Fistula in ano (complete, blind internal, blind external), vesico-vaginal, urethro-vaginal, recto-vaginal, perineal, salivary, biliary, and intestinal.

Describe the signs of each variety of fistula in ano.

Complete Fistula.—There is an external opening in the skin and an internal opening in the bowel. The external opening is usually situated within 1 in. of the anus, the internal opening is generally within 1 in. of the margin of the anus, most frequently immediately above the sphincter. The escape of fluid feces and flatus through a complete fistula is common.

Incomplete fistula may be of two kinds, internal and external. When a sinus leads up to the bowel from an external opening in the skin, but there is no opening into the bowel, it is called a blind external fistula. When there is only an internal opening, but no opening in the skin, it is called a blind internal fistula. External incomplete fistula is diagnosed from complete when the probe will not pass into the bowel. An internal fistula may be suspected when the patient gives all the usual symptoms of fissure

and no fissure can be found. From time to time there will be swelling about the anus, which, after a discharge of pus from the bowel, will disappear. It is only by placing the patient under an anesthetic, stretching the sphincter, and carefully examining the lower 3 inches of the bowel with a speculum, that the affection can be satisfactorily detected.

How would you operate for the radical cure of complete fistula in ano?

The bowels should be completely evacuated by a purgative, given the night before, and also by an enema about an hour before the operation. The patient is etherized, placed in the lithotomy position, and the perineal and anal regions shaved and properly cleansed. The external sphincter is forcibly stretched by the thumbs in the rectum; a grooved director is then passed into the external orifice of the fistula, through the fistulous tract, into the bowel.

A curved bistoury is now introduced along the grooved director, and all the overlying tissues are divided. All pockets and tributary branches of the fistula must be opened up and cureted. All undermined tissue and unhealthy tags of skin should be removed. Hemorrhage should be checked, the cavity carefully packed with iodoform gauze, and compression made over the anal region by a thick pad of sterile gauze and a T-binder.

What are the causes of ischio-rectal abscess?

Predisposing causes: tuberculous and pyogenic infections.
Exciting causes: trauma, fissure, and fistula in ano.

Give symptoms and treatment of acute ischio-rectal abscess.

The *symptoms* are the same as those of abscess anywhere, the swelling, however, being brawny, and fluctuation being hard to detect. Pain in the groin is often complained of, and there may be enlarged glands in this region.

Treatment.—Immediate incision, the cut radiating from the anus like the spoke of a wheel. Incision is followed by insertion of the finger, breaking down the necrotic septa of cellular tissue, irrigation, and packing with iodoform gauze. If a fistula is found to open into the rectum, it is operated upon the same as a fistula in ano.

Describe an operation for the removal of hemorrhoids.

After anesthetizing, stretch the sphincter and treat each hemorrhoid separately. Catch a pile with a pair of forceps, pull it down, and cut a gutter through the skin margin if the pile is of the mixed variety; tie the small piles without transfixing, but transfix the large piles; tie with silk; cut off the tumor beyond the thread, and cut the ligature short. Irrigate with hot salt solution, dust with iodoform, pack a piece of iodoform gauze into the rectum, and apply a gauze pad and a T-bandage.

Give the symptoms and treatment for carcinoma of the rectum.

Symptoms.—Pain on defecation and straining at stool; the stools are ribbon-like; hemorrhage after a bowel movement is severe, and constipation

is apt to alternate with diarrhea. The finger and the speculum make the diagnosis.

Treatment.—If the rectum is movable, perform a radical operation and excise the bowel and suture the ends together; or perform a Kraske's operation and excise a portion of the sacrum; in any case it is better surgery to perform a preliminary colostomy. If the rectum is not movable, perform a colostomy only.

What are the causes of stricture of the rectum?

They are divided into congenital and acquired. There are two forms of acquired stricture. First, the variety due to external pressure, caused by adhesions or a growth. The second form may be caused by syphilitic, tuberculous, or dysenteric ulceration, cicatrices after local inflammation, operation, traumatism, and rectal gonorrhea.

EYE, EAR, NOSE, AND THROAT

Give (1) the causes, (2) symptoms, and (3) treatment of acute iritis.

(1) Syphilis, rheumatism, gonorrhea, smallpox, septicemia, typhoid fever, pneumonia, and diabetes.

(2) Pain in the eye and forehead, lacrimation and photophobia, dimness of vision, unequal pupils, cloudiness of the aqueous humor, punctate deposits on the posterior surface of the cornea, and change of color of the iris.

(3) In syphilitic iritis, mixed treatment; in rheumatic, large doses of salicylate of sodium; in the other varieties treat the constitutional condition. Locally, dilate the pupil with atropin and keep it dilated until all the symptoms have disappeared, and have the patient kept in a dark room, if possible, on a light diet.

State the causes of exophthalmos.

Exophthalmic goiter, intra-orbital aneurysm, intra-orbital tumors, thrombosis of the cavernous sinus, fracture of the anterior fossa with laceration of the cavernous sinus, emphysema of the antrum, tumors of the antrum.

What muscles are divided in the operation for (a) diverging strabismus; also (b) converging strabismus?

(a) The external rectus; (b) the internal rectus.

What is glaucoma? Give the treatment of glaucoma.

Glaucoma is a disease of the eye characterized by increase of intra-ocular tension, excavation of the optic disc, restriction of the field of vision, corneal anesthesia, colored halos about lights, and a diminution in vision that may become absolute.

Treatment.—Iridectomy, followed by eserin if the tension does not decrease.

What are the causes of ptosis and the remedial measures employed?

Paralysis of the oculomotor nerve, cortical lesion in the brain, fracture of the skull, syphilis, rheumatism, and congenital malformation or injury of the levator palpebræ muscle.

Treatment.—If due to syphilis or rheumatism, the appropriate constitutional treatment. In the absence of constitutional causes operations are performed to increase the action of the frontalis muscle upon the upper lid. If the action of the levator muscle is not entirely lost, the muscle may be shortened.

What are the indications for enucleation of the globe?

Malignant disease, either primary or extending from adjacent tissues; rupture and collapse of the eyeball; a large, irregular foreign body in the eye not capable of being successfully removed; a large wound in the dangerous region in which little hope of obtaining useful sight remains; a small foreign body not removable by the electromagnet and causing inflammation and shrinking of the eyeball; a corneal wound in which severe iritis and panophthalmitis develop in spite of treatment; and any case in which sympathetic ophthalmia is threatened.

Describe enucleation of the eyeball.

The conjunctiva near the cornea is grasped with forceps and divided with scissors entirely around and close to the corneal margin. The recti muscles are now caught up separately with a strabismus hook, and their tendons divided close to the ball. After the tissues have been well dissected away from the ball, scissors are passed back in the orbit until they touch the optic nerve, when their blades are opened and the nerve divided as far back as possible. The oblique muscles and other remaining tissues are now quickly divided, and the hemorrhage checked with hot water and pressure.

What is the treatment for stenosis of the lacrimal duct?

Slit up the lower canaliculus inward and slightly upward on the conjunctival surface. Follow this by dilatation with Bowman's probes. The dilatation will be required to be performed every few days for several months.

What is milium? Give the treatment.

Milium is an affection characterized by the appearance of small, pearly, non-inflammatory elevations upon the edges of the eyelids. They result from the accumulation of inspissated sebum in ducts, the outlets of which have been occluded.

Treatment.—The lesion should be incised and the contents removed.

Give the symptoms and treatment of suppurative mastoiditis.

Symptoms.—Pain and tenderness over the mastoid, with pitting over the same area. Temperature, 100° to 103° F.; pulse rapid.

Treatment.—Trephine in Macewen's suprameatal triangle with a surgical engine or a mallet and chisel, being careful not to injure the lateral sinus by going too high, or the facial nerve by going below the above triangle. If the case is due to middle-ear disease, clean out the middle ear.

Describe an approved method for the removal of impacted cerumen.

The external auditory meatus should be syringed with hot water; if this does not remove it, drop in a small amount of a solution consisting of equal parts of hydrogen dioxid and water, to which a small amount of bicarbonate of soda has been added; allow it to remain five minutes, then renew syringing.

What are the principal causes of tinnitus aurium?

Ménière's disease, impacted cerumen, alterations in pressure in the labyrinth, obstruction of the Eustachian tube, large doses of quinin or of salicylates, acute otitis media, chronic catarrhal otitis media, chronic suppurative otitis media, and neurosis of the auditory nerve.

Name the methods of inflating the tympanum.

Valsalva's, Politzer's, and the Eustachian catheter.

What are the indications for incising the membrana tympani?

The evacuation of serum, pus, or mucus from the tympanum, for the relief of anomalies of tension of the drum membrane.

Give the causes and sequelæ of suppurative middle-ear disease.

Causes.—Infection from the nasopharynx through the Eustachian tube. Infection through perforations of the membrana tympani.

Sequelæ.—These may be divided into the extracranial, cranial, and intracranial. *Extracranial:* eczema of the meatus, furuncles of the meatus, and necrosis of the tympanic plate. *Cranial:* necrosis of the ossicles, caries or necrosis of the temporal bone, facial paralysis, and mastoiditis. *Intracranial:* Extradural abscess, meningitis, thrombosis of the lateral sinus, and cerebral or cerebellar abscess.

Where should the opening be made in order to reach the antrum in a case of abscess of the middle ear?

In the posterior superior angle of the suprameatal triangle of Macewen, which is bounded above by the posterior root of the zygoma, in front by the upper and posterior segment of the osseous external meatus, and behind by an imaginary line joining the two. Care should be taken not to wound the sigmoid sinus or the facial nerve.

OBSTETRICS AND GYNECOLOGY

OBSTETRICS

PHYSIOLOGY

Define fecundation and describe its physiology.

Fecundation is the *fertilization of the ovum.* It is effected, according to some, in the tubes or upon the ovarian surface; according to others, within the cavity of the uterus, at the fundus. The *spermatozoids* penetrate the vitelline membrane of the ovum through the micropyle. The ovum then undergoes a series of progressive changes.

Define conception and fecundation.

They are synonymous terms, meaning the union of ovule and spermatozoön.

Define insemination and state the conditions necessary to its accomplishment.

Insemination is the ejaculation of seminal fluid from the male and its deposition in the female genital canal. Its accomplishment depends on a normal, healthy condition of the generative organs in the male.

What are spermatozoa? Where are they found? Describe their appearance and function.

They are microscopic elements, about $\frac{1}{600}$ inch in length, of a tadpole shape, flat, oval heads, small bodies, and a very long flagellum, which latter is in constant motion. They are found in very large numbers in the semen, being derived from the epithelium of the seminal tubules. Their *function* is the fertilization of the ovum.

Describe the fertilization of the ovum.

The spermatic particles, attracted by some form of secretion, approach the ovum, the head effecting an entrance and fusing with the protoplasm, while the tail disappears. The head, after penetrating the cell contents, becomes the *male pronucleus* and unites with the *female pronucleus.* Conception occurs at the moment of this fusion.

Describe the fully developed ovum.

It is the vital element and reproductive cell of the female. It is about $\frac{1}{125}$ inch in diameter, and composed of a protoplasmic yolk, or *vitellus,* and a nucleus, or *germinal vesicle,* enclosed within a hyaline covering, the *zona pellucida.*

When is conception least likely to follow intercourse?

From the *seventeenth* to the *twenty-third* day after menstruation has ceased. Insemination is said to be most likely to result in impregnation upon the day following the cessation of a menstrual period.

Give the successive changes that take place in the ovum after fecundation and during its passage to the uterus.

1. Penetration of ovum by a spermatozoön, with loss of the tail and fusion with the female pronucleus. 2. Segmentation, forming *blastodermic vesicle*, which is composed of a mass of cells (*morula*, or mulberry mass) and a cavity containing albuminous fluid, the whole surrounded by a layer of 'cover cells.' 3. Arrangement of cells into *entoderm* and *ectoderm*. 4. Differentiation on surface into *embryonal area* with its *primitive streak*. 5. Appearance of the *primitive groove* and *mesoderm*. 6. Development of the mesoderm to form the parietal layer, which unites with the ectoderm to form the *somatopleure*. 7. Development of the embryo proper (at the end of the second week) by the formation of *neural folds*, *neural canal*, *chorda dorsalis*, and the *prevertebræ*. The further development depends upon an arching-over process of cells which inclose the spinal canal, the abdominal and thoracic cavities, and the cranial cavity.

What is superfetation, and how does it take place?

The impregnation of a second ovum after the development of the first ovum has been going on in the uterus for a month or more. The occurrence of superfetation cannot be accepted as definitely proved.

Name the fetal envelopes from without inward.

Decidua vera, decidua reflexa, chorion, and amnion.

Describe the vitellus, the allantois, and the amnion.

The *vitellus* is the protoplasmic cell-body of the ovum; it contains a very small quantity of food-yolk. The *allantois* is a small offshoot, extending from the caudal extremity of the hindgut, and made up of mesoderm externally and entoderm internally. The umbilical vessels spread out over the allantois and are thus distributed to the chorion. This structure is, therefore, the forerunner of the placenta. The *amnion* is a smooth, tough, transparent, fibrous structure, the innermost of the fetal membranes surrounding the fetus, and containing the amniotic fluid.

What is the character of the liquor amnii and what are its sources and uses?

An almost clear fluid of an alkaline reaction, a specific gravity of 1002 to 1028, containing salts, urea, carbonate of ammonia, albumin, lanugo, sebaceous matter, epithelium from fetal kidneys and bladder. The average quantity at the end of pregnancy is 680 gm. The *origin* of this fluid is partly maternal and partly fetal (urine). Its *uses* are to allow the fetus a certain freedom of movement without much muscular exertion; to protect against violence and sudden change of temperature; to receive the urine secreted in the last months of pregnancy; and possibly also to supply water to the fetus.

What is the umbilical cord and how is it formed?

The *funis* is the cord-like structure which passes from the fetus and carries the fetal blood-vessels to the placenta. At term it measures about 50 cm. in length. Its forerunner is the *abdominal stalk*. It is developed from the pedicle of the allantois.

What structures compose the fully developed umbilical cord?

Two arteries, one vein, the vitelline duct, the pedicle of the allantois, and Wharton's jelly. Both arteries and veins have valves.

What is the placenta? From what is it formed?

The placenta is the essential nutritive and respiratory organ of the fetus. It is formed from the *chorion frondosum* and the *decidua serotina*, assumes its functions about the end of the third month, and is situated, as a rule, near one of the tubal orifices, though it may be found at any point of the uterine wall.

Describe the placenta.

The placenta is circular, measuring about 7 inches in diameter and $\frac{3}{4}$ inch in thickness, and weighs about 1 pound. Upon its maternal side it is deeply lobulated and covered by the *serotina*. Upon the fetal side it is covered by the *amnion;* from this surface the cord passes to the fetus. Around the periphery is seen a large vein.

Describe the development of the placenta.

As a separate organ it dates from the third month of pregnancy. At this time the *chorionic villi* atrophy, except where they come in contact with the uterine mucous membrane at the decidua serotina. In this latter situation there is a great increase of the villi, with the development of blood-vessels within them. Between the villi, processes of the decidua dip down to the base of the chorionic parent stems, which carry maternal blood-vessels. The placental villi are thus bathed in maternal blood and imbed themselves into the soft interglandular substance of the decidua serotina, the connective-tissue cells multiplying and hypertrophying around them. The chorionic villi are at first covered with a double layer of cells—the inner, or *Langhans' layer*, consisting of single, large, nucleated cells with a distinct wall; and an *outer* layer of protoplasm, in which are imbedded nuclei at irregular intervals (*syncytium*). Both layers are derived from the chorion. The Langhans layer disappears early in fetal life. The uterine mucous membrane throws loops of capillaries around the villi; later these vessels disappear and large sinuses remain. The syncytial cells have the power of penetrating the walls of the arterioles and thus, while the maternal blood is kept distinct from the fetal, there is nevertheless a direct communication by osmosis.

What are the functions of the placenta?

1. The supplying of nourishment to the fetus. 2. The oxygenation of the impure fetal blood. 3. The excretion of the effete products derived from the fetus.

Describe the human embryo during the second month, the fifth month, the seventh month, and the ninth month, giving the size and weight.

Second month: At the end of the first month the ovum is the size of a pigeon's egg, and during the third month attains that of a hen's egg. The embryo during the second month attains a length of 2.5 cm. (1 inch). Closure of the visceral clefts. The head forms more than two-thirds of the embryo; features may be distinguished; the hands and feet are webbed. The weight of the embryo is 4 gm.

Fifth month: Length, 18 to 27 cm.; weight, 273 gm. Umbilical cord about 3.1 cm. long. Head still relatively very large; the face has a senile look, and the eyes begin to open. The skin is covered with lanugo; some vernix caseosa is present.

Seventh month: Length, 35 to 38 cm.; weight, 1170 gm. The whole body is covered with lanugo except the palms of the hands and the soles of the feet. The large intestine contains a considerable quantity of meconium. The pupillary membrane disappears.

Ninth month: Length, 42 to 44 cm.; weight, 1942 gm. There is a decided increase in subcutaneous fat. The nails are not yet perfectly developed.

Describe the fetal heart-sounds, give their rate, and state when and where they are best heard.

The sound resembles the ticking of a watch under a pillow. The *rate* is about twice that of the maternal heart, averaging 120 to 160 beats in a minute. The position of *maximum intensity* varies with the fetal presentation; in anterior vertex presentations it is at a point a little to the right or left of the umbilicus, depending on the side toward which the fetal back is directed. In posterior positions the maximum intensity is in the flank. In presentations of the breech the sounds are best heard above the transverse line passing through the umbilicus, either to the right or to the left; while in transverse positions of the child they may be found just above the symphysis pubis. Fetal heart-sounds are an *absolute sign of pregnancy* and are available as early as the *fifth month.*

PREGNANCY

What is understood by the hygiene of pregnancy? What methods are used to maintain the health of a patient during pregnancy?

The management of the patient according to the rules of health. This includes the regulation of the diet, clothing, exercise, bathing, sexual intercourse, and attention to the kidneys and bowels.

What is the normal duration of pregnancy? What are the limits of the possible variations, and how is the duration to be calculated?

In the human being it covers 280 days (10 lunar or 9 calendar months). It may be extended up to 302 days and still be considered legitimate. There is often a premature termination, which may occur at any time after con-

ception. The usual manner of estimating the duration of pregnancy is to count back three months from the date of the first day of the last menstrual period and then to add 7 days. The date of *quickening* is usually at or near the middle of the fifth month. Measurement of the height of the uterus is also of value.

What is the earliest period of gestation at which the fetal heart-sounds may be reliably heard?

The *fifth* month, as a rule. Sometimes as early as the fourth month.

What is the usual period for quickening to occur?

The *fifth* month of gestation.

What are the effects of pregnancy upon the maternal organism?

In addition to the changes in the pelvic organs a deposit of fat in the abdominal wall, an edema of the pelvic joints, congestion of the pelvic viscera, an increase in the amount of blood and urine, alterations in taste and disposition, and a softening of the bones of the entire body.

State the changes occurring in the external genitals and vagina during pregnancy.

An increased vascularity, with edema and softening of the tissues, and a bluish discoloration of the mucous membrane.

Describe the change in position which the uterus undergoes during pregnancy.

At first it sinks to a lower level in the pelvis. It then rises progressively into the abdomen until it reaches the ensiform cartilage, a few weeks before labor. After this time it sinks to a level which about corresponds to that of the eighth month. The secondary sinking is termed '*lightening*.'

What changes occur in the uterus during pregnancy?

Hypertrophy of the muscular tissue; hyperplasia of the peritoneum; increase in the connective tissue; rapid development of the blood-vessels, with reduction of the venous walls to the intima; increase of nerve elements by the development of the neurilemma; hypertrophy and hyperplasia of the lymphatics. The length of the organ increases from 2½ inches to 12 inches. The capacity changes from 1 cubic inch to 400 cubic inches. Its weight changes from 1 ounce to 2 pounds. There is a slight right-sided rotation and tilting.

What changes occur in the blood during gestation?

The quantity of blood increases, but this is most marked in the fluid constituents, as the cellular elements do not keep pace and so there is a combined *hydremia* and *anemia*. There is an increased amount of *fibrin* ferment and so a greater tendency to clot than normal. There is an actual *leukocytosis*. The percentage of lymphocytes, polymorphonuclear cells, and eosinophiles is unaltered.

Give the signs of pregnancy with their relative values.

The *doubtful* signs are: vesical irritability, gastric irritability, as shown by the occurrence of nausea or vomiting; nervous irritability; changes in the breasts and genitalia due to increased blood supply; changes in size and shape of the abdomen.

The *probable* signs are: total menstrual suppression; increasing size of the uterus; deposition of pigment in areolæ of breasts; development of Montgomery's tubercles; softening of the cervix; Hegar's sign; vaginal discoloration; uterine contractions.

The *positive* signs are: fetal movements (objective), fetal heart-sounds, and ballottement.

Name the objective signs of pregnancy.

Ballottement, fetal movements, fetal heart-sounds, vaginal discoloration, intermittent uterine contractions, softened cervix, softening of the lower uterine segment (Hegar's sign), darkening of the areolæ of the breasts, colostrum in the breasts, uterine enlargement, and outlining fetal body.

Divide pregnancy into three periods of three months each and give the signs of the condition which are developed in these periods.

In the *first* three months: enlargement, change in shape, and bogginess of the uterine body, soft cervix, enlargement and functional activity of the breasts, Hegar's sign, cessation of menstruation, nausea, and vomiting.

In the *second* three months: enlargement of the abdomen, intermittent contractions of the uterus, feeble fetal movements, ballottement, fetal heart-sounds, and blue discoloration of the vaginal mucous membrane.

In the *third* period all the above and, in addition, the outlines of the fetal body may be determined and the presenting part may be felt in the vaginal vault.

What are the diagnostic points in the diagnosis of pregnancy before the fourth month? After the fifth month?

Before the fourth month the symptoms are: enlargement, change in shape, and bogginess of the uterine body, soft cervix, enlargement and functional activity of the breasts, Hegar's sign, nausea and vomiting, and cessation of menstruation. *After the fifth month* the above and, in addition, enlargement of the abdomen, intermittent uterine contractions, feeble fetal movements, ballottement, fetal heart-sounds, and blue discoloration of the vaginal mucous membrane.

What is to be learned by abdominal auscultation in pregnancy?

The position and frequency of the fetal heart-sounds. The placental or uterine bruit. Occasionally the funic souffle.

What may be learned by palpation of the abdomen after the eighth month of pregnancy?

The presence of fetal movements; the position and presentation of the fetus; the uterine size and position, with the degree of distention of the uterine and abdominal walls; the mobility of the fetal head, and its adaptability to the pelvic inlet.

State the diagnosis, complications, and treatment of multiple pregnancy.

Diagnosis.—A marked distention of the abdomen, the presence of three large parts (two heads and a breech or two breeches and a head, two of which can be moved independently of the third) are suggestive signs; but the only *absolute sign* is the presence of two distinct fetal heart-beats of different rates, neither being synchronous with the maternal pulse.

Complications are albuminuria, inertia uteri, post-partum hemorrhage, sepsis, obstruction to labor (locked twins), hydramnios, malpositions.

Treatment.—As soon as the first child is delivered, an examination is to be made to determine the position of the second. The cord of the first child is to be cut between two ligatures. If the second child is not promptly delivered, ergot is to be administered and forceps may be indicated. Great attention must be given to the uterus, as there is always an increased danger of relaxation. In cases of interlocking of twins it may be necessary to perform a mutilating operation upon one.

How is the differentiation between the first and a subsequent pregnancy to be made?

By the presence of lacerations of the cervix and perineum (positive), by gaping of the introitus vaginæ (suggestive). Pendulous breasts, laxity of the abdominal walls, and abdominal striæ are suggestive.

Give the causes of the vomiting of pregnancy.

Reflex irritation; endometritis; engorgement of other organs; pathologic conditions of the stomach or intestinal tract; sexual intercourse; kidney insufficiency or other intoxication.

What is 'morning-sickness,' when does it begin, how long does it usually continue, and what are its causation and treatment?

Nausea and vomiting occurs at the sixth week of pregnancy so usually that it is one of the most important early signs of impregnation. It usually lasts about six weeks. It may appear earlier or it may be absent throughout. At this stage it is usually due to a peripheral stimulation of the nervous radicles in the uterine wall. Treatment does not offer much relief, but the best results are to be expected from the bromids, oxalate of cerium, etc. A continuation beyond the normal period of cessation should arouse the suspicion that the causation is an intoxication, and the same thought should occur if it has its inception late in the course of pregnancy. (For causation, see previous question.)

Differentiate the ordinary type of 'morning-sickness' from the hyperemesis of pregnancy. What are the causes of the latter and what is its management?

In the so-called *physiologic* vomiting of pregnancy there is the ability to take food, as a rule, after the early morning hours have passed, and the weight does not markedly suffer. On the other hand, in the true *pernicious type* there is absolutely no retentive power in the stomach, and the body-weight rapidly fails. In other words, the difference, while only one of degree, is most marked.

The *causes* of the exaggerated form are marked distention of the uterus, metritis, displacements of the uterus, particularly with adhesions; sclerotic cervix, endometritis, disease in neighboring organs, as appendix or ovaries and tubes; sexual intercourse, autointoxication, and kidney disease.

Treatment.—Hygienic, correction of any local condition, as displacements; restricted diet and in bad cases rectal feeding; *drugs* (little value), *termination* of *pregnancy* if, after a week or ten days of rectal feeding, there is no improvement. It is to be noted that the symptom of pernicious nausea is of as serious import as the actual vomiting, and that in all bad cases care must be exercised not to let them go too far before terminating the pregnancy.

What is the significance of glycosuria in pregnancy?

As compared to albumen it is relatively rare. Two varieties are noted: one, due to *lactose*, is caused by absorption from the breasts and demands no treatment; while the other, in which the sugar is *glucose*, makes rigid dieting a necessity. True diabetes is more likely to affect pregnant women than the non-pregnant; it may appear during pregnancy and disappear after delivery.

What is the cause of difficult and painful urination in pregnancy?

If of a severe type, it is usually due to a uterine retrodisplacement, the cervix tilting up against the base of the bladder, and the traction of the uterus upon the bladder causing the pain.

Describe the performance of external palpation of the pregnant abdomen.

Patient on back with limbs slightly flexed; hands applied laterally to determine the resistance of the fetal back or the irregular protuberances of the extremities; tips of the fingers carried beneath Poupart's ligaments to detect the presenting part in the pelvic brim.

What is ballottement and how is it performed?

By placing one hand over the fundus, and the fingers of the other in the vagina, an impulse may be conveyed by the latter to the uterine contents, which are displaced upward, give an impact to the external hand, and fall again into their original situation.

This is a *positive sign* of pregnancy. Rare cases of extrauterine pregnancy may simulate it.

Differentiate uterine bruit and umbilical souffle.

The *uterine bruit* (placental souffle is a mistaken term) is a rhythmic blowing sound synchronous with the maternal heart-beat. The *umbilical* or *funic souffle* is a high-pitched, hissing sound, synchronous with the fetal heart, and is due to some obstruction in the blood-vessels of the cord.

Describe the proper management of the breasts before labor.

During the last month the nipples, if retracted, should be gently pulled out by the fingers or the pump. General cleanliness should be insisted

upon, and the nipples should be treated by some application, as the *glycerol of tannin* or cocoa-butter, in order that they may withstand the maceration incident to nursing.

Describe the mammary glands and the changes that take place in them during pregnancy. When the child is still-born, what care should be taken of the maternal breasts?

The *breasts* contain fat, connective tissue, and glandular structure. The glandular structure is composed of excretory ducts, lobes, and lobules. The lobules are divided into vesicles; these empty into small excretory ducts which in their turn unite to form a large *lactiferous canal* which conveys the secretion to the nipple. The *changes in pregnancy* depend upon congestion. The organ enlarges; veins are evident upon its surface; and fine lines, the result of the distention, appear. The color of the areola changes and the glands of Montgomery develop. As a result of the congestion there is the formation of secretion.

If the child is *still-born*, a binder must be applied to the breasts, and applications, as of belladonna, made to prevent milk formation; the use of the breast-pump is indicated at intervals of some hours if distention is painful.

What is the pathology of pregnancy? Name some of the diseases to which pregnancy predisposes.

The pathology of pregnancy is concerned with those abnormal conditions dependent upon pregnancy for their existence, as abortion, hydatidiform mole, extrauterine pregnancy. It may also be made to include the study of diseases which, while not dependent upon the existence of pregnancy for their occurrence, are nevertheless predisposed to by it. A few of them are: Bright's disease, pernicious vomiting, constipation, hemorrhoids, appendicitis, anemia, varicose veins, hemorrhage, uterine displacements, insanity, neuralgias, and osteomalacia.

What abnormal conditions in pregnant women are prejudicial to the life of the mother or the child?

Toxemia; pernicious vomiting; acute zymotic diseases; gonorrhea; placenta prævia; premature detachment of the normally situated placenta; grave cardiac or pulmonary lesions.

What are the effects of an acute zymotic disease occurring during pregnancy on (a) the mother and (b) the child?

As a rule, the severity of the disease is more marked in the mother; while the child may perish because of an abortion, to which there is a strong tendency. In other cases its development may be simply interfered with or, in rare instances, the child may contract the maternal disease through placental transmission.

To what dangers in pregnancy and labor does gonorrhea of the mother expose her and her offspring?

Possibility of local peritonitis and pus-tubes; an increased risk of puerperal sepsis after delivery; the development of ophthalmia in the child.

Name some of the conditions or diseases which might complicate pregnancy or be mistaken for it.

Pseudocyesis; fibroid tumors; ovarian cysts; ascites.

How is an ovarian tumor to be diagnosed from pregnancy?

By the characteristic signs of an abdominal or pelvic growth which is separable from the uterus, the latter organ being demonstrated not to correspond in size with the period of the supposed pregnancy. After determining that the uterus is not concerned in the growth, the cystic nature of the tumor is determined by its own peculiarities.

How would you diagnose an ovarian tumor complicating pregnancy? What are the possible dangers? Give the treatment.

By the presence of the symptoms and signs of pregnancy and, in addition, the detection of a mass in the abdomen or pelvis which gives dulness on percussion, is more or less movable, and has a cystic feel. In early pregnancy there is often but little difficulty in the diagnosis, but later on great difficulty may be experienced. An examination under ether may be needed to clear up the diagnosis. The *dangers* are those of abortion, degeneration of the cyst, possible blocking of the birth-canal at term (rare), and rupture of the cyst, with the development of peritonitis.

Treatment consists in the removal of the tumor when diagnosed.

Diagnose pregnancy in the sixth month from phantom tumor.

By a vaginal examination, made if necessary under ether, it is demonstrated, if the case is one of phantom tumor, that the uterine enlargement which would correspond to a gestation of the sixth month is not present.

Give the medicolegal complications that may arise, due to an erroneous diagnosis of pregnancy.

Unjust suspicion may be raised against an innocent woman; it may alter the terms of a will or the division of an estate; may result in a lawsuit against the physician; conjugal unhappiness with divorce may result.

To what form of nephritis are pregnant women most liable? How is the condition to be diagnosed and treated?

Either acute or chronic nephritis may occur in pregnancy. The most frequent condition is probably an *acute exacerbation of a chronic nephritis* which had its inception before pregnancy. The varieties of true nephritis are much less often found in pregnancy than is the so-called *kidney of pregnancy.*

The diagnosis and treatment are the same as when the disease occurs at other periods of life.

Give the etiology, symptoms, and management of albuminuria of pregnancy without structural kidney lesions. What is the prognosis?

By the albuminuria or *kidney of pregnancy* is meant a peculiar condition seen in a certain number of pregnant women, in which albumin appears in the urine in varying amounts, unassociated with any grave organic change in the kidneys. The condition is one of hemic *intoxication*, the

poisons originating in the liver very probably, and being due to a faulty metabolism. These poisons irritate the kidneys, producing an arterial contraction, and rendering the kidney pale and anemic, and unable to perform the work of elimination.

The *treatment* consists in a careful attention to the condition of the urine, with an appropriate dietetic, hygienic, and therapeutic regimen. Milk diet, large amounts of water, diuretics, laxatives, irrigation of the bowel with hot normal saline, and the exhibition of nerve sedatives are indicated. If the condition becomes progressively worse, induction of labor may be demanded. The *prognosis* is guardedly favorable.

State the significance of the albuminuria of pregnancy and give an outline of its treatment.

About 6 per cent. of all pregnant women have albumin in the urine at some period of pregnancy, due to 'kidney of pregnancy' or to inflammatory disease. In either the effects may be the same; *i. e.*, deleterious effects upon the general health and the course of pregnancy, and the production of eclampsia.

Treatment.—Frequent examinations of urine; small amount of proteid; large quantities of water; careful attention to hygiene. In the presence of signs of insufficiency of kidney action a liquid diet, and measures to stimulate excretion by the skin, kidneys, and bowels, are indicated, with the termination of gestation if serious toxemic symptoms appear.

State the varieties of puerperal convulsions and give their differential diagnosis.

Eclamptic, hysteric, epileptic, those due to brain tumors or meningitis, to anemia, to apoplexy, or to exaggeration of nervous irritability.

Eclamptic variety diagnosed by the characteristic symptoms of kidney break-down; *hysteric*, by exclusion together with the history of the case, and short duration of attack; *epileptic*, and those due to *tumors*, *meningitis*, *anemia*, and *apoplexy*, by characteristic symptoms of these conditions, while attacks due to nervous irritability must be differentiated by exclusion.

What are the danger signals of impending eclampsia?

Sharp pains in head, epigastrium, or under the clavicle; vomiting or nausea; muscæ volitantes, with failure of vision; great restlessness or stupor.

Give the causes and pathology of puerperal eclampsia and state the relative frequency in primiparæ and multiparæ.

Causes.—Eclampsia is the result of the retention of substances that should be eliminated by the liver and kidneys. An irritation of the arterioles results, causing sudden and marked contraction of their wall and an acute *anemia of the brain*, this latter condition being the cause of the convulsive manifestation.

Pathology.—Extensive degeneration of the renal epithelium or actual inflammatory changes. In the liver, kidney, brain, and lungs are found thromboses, extravasations, and necrotic areas. Degeneration of the myocardium; edema of the lungs or pneumonia.

The condition affects primiparæ more frequently than multiparæ.

What is the prognosis of puerperal eclampsia?

The *causes of death* are: edema of the brain, of the lungs, or of the larynx; apoplexy, asphyxia; exhaustion and heart failure; thrombosis and embolism; an overwhelming accumulation of poison in the system. The mortality is greatest in pregnancy and least in the puerperium. The greater the number of convulsions and the shorter the interval between them, the graver the outlook. Death may follow the first, while recovery has been seen after thirty convulsions. Rapid pulse and high temperature are unfavorable symptoms. The *mortality* may be stated as about 30 per cent. in general practice. The child perishes in about 50 per cent. of the cases.

Describe an eclamptic attack.

After a short period of premonitory symptoms (as above) the attack comes on with a stare; the pupils are at first contracted; the eyelids twitch, the eyeballs roll, and the mouth is drawn to one side, the neck is then affected, and the head is pulled first to one and then to the other side. The spasm extends to the trunk and upper extremities, the arms being flexed fingers bent over the thumb, while the upper extremities work to and from the median line in front of the chest. The respiratory muscles are in spasm, and, with the closed lips and teeth, give rise to the jerky breathing with sucking sound. Lower extremities are rarely affected beyond a flexion of the thighs upon the abdomen. Consciousness is lost during, and for some time after, the convulsion, and unbroken coma gradually develops. Temperature rises with each convulsion.

What is the treatment of eclampsia?

Its *prophylaxis* depends upon the frequent examination of the urine and the prompt combating of all symptoms of intoxication. Its *presence* demands active elimination by skin and bowels by means of steam baths and purgation (croton oil, salts, etc.); control of seizures by chloroform anesthesia; the use of chloral and morphin; veratrum viride in large doses; venesection; hypodermoclysis and transfusion; in certain cases termination of pregnancy.

What are the possible results for the mother and child in the presence of the toxemia of pregnancy? What are the causes of the condition and what is the treatment?

In extreme cases there may be the occurrence of eclampsia with the death of both. The *cause* is the failure of elimination of the poisons produced in the maternal and fetal organisms. The *treatment* is eliminative, with most careful hygiene and, if serious symptoms of intoxication manifest themselves, termination of the pregnancy.

How is the severity of an interstitial nephritis to be measured and treated in a pregnant woman?

By the early appearance of albuminuria and casts, edema, and headache. If the symptoms become marked, abortion is indicated.

How is the probable date of delivery estimated?

By counting back three months from the first day of the last menstruation and adding seven days. (In April and September six days, in December and January five days, and in February four days should be added.)

In determining the date of delivery, what margin of time must be allowed, and why?

About two weeks, because of the impossibility of determining the period which elapsed between the last menstrual flow and the occurrence of conception.

What are the indications for the interruption of pregnancy?

Induction of abortion may be indicated in the presence of: pathologic vomiting, kidney disease, death of the fetus, acute hydramnios, cystic degeneration of the chorionic villi, uterine hemorrhage, uterine displacements, insanity, chorea, pruritus, pernicious anemia. *Induction of premature labor* may be demanded by any of the above conditions and, in addition, by contracted pelves, placenta prævia, phthisis and heart disease, and habitual fetal death.

Name the diseases of the endometrium and state their influence upon pregnancy.

Endometritis may be *gonorrheal* in origin and tend to abortion or to sepsis after delivery; *tuberculous*, in which condition the tendency to the occurrence of pregnancy is diminished; *syphilitic*—a frequent cause of abortion. *Diffuse hyperplasia of the decidual endometrium* is an exaggeration of the normal change occurring in pregnancy and, if of severe type, will induce abortion. *Polypoid endometritis* is a disease of early pregnancy and always results in abortion. *Catarrhal endometritis*, with the collection of a considerable quantity of fluid between the chorion and the deciduæ tends to early occurrence of labor. *Cystic endometritis* is the result of a hypersecretion of the uterine glands, the accumulated fluid being prevented from escaping. It is a disease of very young ova and tends to abortion. *Exanthematous decidual endometritis* tends to the production of abortion. *Hemorrhagic decidual endometritis*, seen in a few reported cases of cholera, has the same tendency. *Atrophy of the deciduæ* may occur, with the result of a peduncular attachment between the uterus and ovum, or abortion.

ABORTION

What are the causes of abortion?

Death of fetus; diseases of the membranes, including the deciduæ; pathologic conditions of the placenta and apoplexies of the ovum; traumatism and maternal diseases (heart disease, the exanthemata); lacerations of the cervix; irritable uterus; spasmodic maternal muscular action (seen in chorea, eclampsia, epilepsy); conditions of the maternal blood which stimulate the uterus to contract (pneumonia, the exanthemata); abnormal position of the uterus; overdistention of the uterus. One of the most common causes is maternal syphilis.

What are the attendant dangers and the subsequent conditions liable to follow abortion?

Hemorrhage, sepsis, and lacerations of the cervix are the immediate dangers. The pathologic conditions subsequent to an abortion are uterine subinvolution, endometritis, salpingitis in one of its forms, pelvic adhesions, chronic metritis.

Why is abortion or miscarriage more dangerous than delivery at term?

Because of the tendency to retention of a portion of the deciduæ, etc., with a resultant hemorrhage, chronic salpingo-oöphoritis or septicemia. In criminal abortions there is the added risk of traumatism from unskillful use of instruments, and also of sepsis.

What is the proper treatment for a case of continued menstruation during pregnancy?

May have no significance, but it is safer to treat all cases as threatened abortion by keeping the patient quiet, particularly at periods corresponding to the menstrual epochs.

How should inevitable abortion be managed?

Marked bleeding without dilatation demands the use of a vaginal tampon of gauze, which is allowed to remain *in situ* for twelve to twenty-four hours and then replaced if it is needed. In many cases the cervix will have dilated enough, after the introduction of the first tampon, to allow the aseptic evacuation of the uterine contents, which is the best treatment. When the tampon is removed, moreover, it will be found in a number of cases that the fetus and membranes are wholly or in part extruded with it. In evacuating the uterus the woman is anesthetized, and removal accomplished by the finger, the dull curet, and Emmet's curetment forceps.

When and in what manner should abortion be induced?

The presence of a pathologic state which distinctly threatens the life of the mother, as pernicious vomiting; marked toxemia; certain blood diseases, as pernicious anemia and leukemia; uterine hemorrhage; displacements of the uterus; acute mania, melancholia and chorea; death of the embryo; and certain intra-uterine diseases, as acute hydramnios and cystic degeneration of the chorionic villi. In all cases a consultation is advisable.

The *method* to be employed is dilatation of the cervix under ether, the introduction of a placental forceps to crush the ovum, and the removal of a portion of it. A tampon is then introduced into the uterus and vagina and allowed to remain in place for twenty-four hours. If on the removal of the tampon the evacuation is not complete, the cervix can be easily dilated and the remainder of the product of conception removed with the curet.

Define abortion, miscarriage, and premature labor.

An *abortion* is the expulsion of the fetus before the *fourth* month (placenta not entirely differentiated from the remainder of the chorion). A *miscarriage* is expulsion *between the fourth and the sixth month*. A *premature labor* is the birth of the child *after viability and before full term.*

What are the means to be employed to prevent threatened abortion during the first three months of pregnancy?

Avoidance of overexertion; correction of uterine displacement; rest in bed at the menstrual epochs; administration of the bromids, viburnum

prunifolium, and opium in suppository. As prophylaxis must also be mentioned the avoidance of sexual intercourse and, in the interval between pregnancies, the repair of all cervical lacerations, uterine retrodisplacements, and endometritis.

What are the premonitory symptoms of abortion?

Discomfort and fulness in the pelvis; sacral pains; vesical tenesmus; discharge of serum in increasing amounts from the uterus. If there is a bloody discharge from the pregnant uterus, abortion may be considered as the most likely conditional, though extra-uterine pregnancy must be remembered.

What are the symptoms of threatened abortion?

Pain, increasing hemorrhage, and dilatation of the cervix.

Describe the symptoms and the management of an incomplete abortion.

The uterus is found to be enlarged, soft, and boggy; the cervical canal will be at least somewhat dilated; clots, placental fragments etc., will be found in the cavity of the uterus; there will be a discharge of blood with or without a foul odor.

The *treatment* consists in dilatation of the cervical canal, evacuation of the uterus with the finger, curet, and placental forceps, and an intra-uterine douche of sterile water, bichlorid of mercury, or other medicinal agent.

What are the symptoms of an inevitable abortion?

Persistent hemorrhage, dilatation of the os uteri; tumor (cystic) presenting in the os; marked and increasing pain; effacement of the acute angle between the cervix and body of the uterus (Tarnier's sign); expulsion of a portion of the ovum.

Why is Tarnier's sign of importance in the diagnosis of inevitable abortion?

It denotes that a contraction has taken place in the longitudinal fibers of the uterus, with consequent descent of the ovum.

Name six methods of inducing premature labor.

1. Scheele's perforation of the membranes. 2. Cohen's—by injection of aqua picis between the membranes and the uterine wall. 3. Pelzer's—by injection of glycerin. 4. Champetier de Ribes'—by the introduction of the bag bearing his name. 5. Krause's—by the introduction of one or more bougies between the membranes and the uterine wall. This is the best method, and may be advantageously combined with the introduction of a rubber bag placed in the lower uterine segment. 6. Metal dilators, as that of Bossi, are recommended by some.

State the obstetric import of anteversion, anteflexion, prolapse, and retrodisplacement of the uterus.

Anteversion may be found after various operations for the relief of backward displacements of the uterus. It may be the cause of considerable dystocia. *Anteflexion* is sometimes seen at term in women with

pendulous abdomen. It may, if not properly treated by the application of an abdominal binder, be the cause of dystocia. Both these conditions may occasionally produce abortion. *Prolapse* of the uterus, if complete, is not compatible with a continuation of pregnancy to term. Retraction may, however, take place to such a degree that pregnancy may continue. *Retrodisplacement* of the uterus is usually spontaneously corrected; but if this does not occur, abortion will result, except in the rare cases in which the organ becomes sacculated.

LABOR

What is labor?

Labor is the natural process by which a pregnant woman expels the product of conception at the full expiration of the period of pregnancy, two hundred and eighty days after conception.

What are the prodromata of labor?

The onset is indicated from two to four weeks before by the process known as "*lightening*" (entrance of the head into the superior strait). The actual onset of labor is indicated by characteristic pain, dilatation of the os, and a bloody discharge known as the "*show*."

Define eutocia and dystocia.

Eutocia is normal or easy labor. *Dystocia* is abnormal, difficult, or extremely painful labor.

Describe the preparation of the bed, the woman, the physician, and the nurse for a case of labor.

Careful asepsis, as regards bed, linen, and patient, as well as doctor and nurse. The bed should be made ready by covering the mattress with a mackintosh, over which a sheet is spread; upon this is placed another small piece of mackintosh, a sheet, and the delivery pad of nursery cloth. After labor the pad and the upper rubber sheet are removed, and another delivery pad is placed under the woman. As soon as labor begins, the woman is given a full bath, and, after the expulsion of an enema, the external genitalia are cleansed. The physician and nurse disinfect themselves as for a major operative procedure.

Describe the uterus and adjacent parts just prior to labor.

Uterus.—Hypertrophy of the muscle-fibers; increase of connective tissue; hyperplasia of the peritoneum; great development of the blood-vessels, nerves, and especially the lymphatics. The muscle fibers of the uterus are divided into three layers. The capacity increases from 1 cu. in. to 400 cu. in. The uterus is ovoid in shape. The *vagina* and *vulva* show development of their walls, with increased secretion and markedly increased blood supply. The pelvic joints become loosened. The *broad ligaments* hypertrophy and their blood-vessels increase greatly in size. General pelvic congestion is present. The *cervix* is soft and its canal is obliterated; the external os is often patulous in multiparæ. The *ovaries* and *tubes* are found lying close to the uterine wall and are greatly increased in vascularity. The *corpus luteum* is of large size.

Describe and give the cause of 'Bandl's ring,' the 'hour-glass ring.' Diagnose each briefly.

Bandl's ring, or the contraction ring, divides the body of the uterus into two parts. It is situated at the site of reflection of the peritoneum, opposite a large coronary vein. It is never found except during labor. The "*hour-glass*" ring or contraction is the name given to it after the delivery of the child. Rarely the placenta is retained by this contraction.

Into what stages is labor divided and what differentiates them?

There are three stages of labor. The first, or stage of *dilatation*, begins with the first labor pain and continues until the os is fully dilated. The second stage, or stage of *expulsion* or *descent*, extends from full dilatation until the delivery of the child. The third stage, or the *placental*, extends from the delivery of the child until the after-birth is born.

Give a description of the three stages of labor.

The first, or stage of *dilatation*, lasts from two to twenty hours, and causes the dilatation of the cervix and lower uterine segment. Pains recur at intervals of from five to thirty minutes. The second, or stage of *descent*, lasts from a few minutes to a couple of hours and ends with the expulsion of the child. The pains recur during this stage at intervals of from one-half to five minutes, and are associated with abdominal contractions. The third or *placental* stage lasts about half an hour and ends with the expulsion of the placenta.

Give the management of the second stage of labor.

The patient should remain in bed. In multiparæ, if the membranes fail to rupture after full dilatation of the os, they should be broken in the interval between the pains. When the head reaches the perineum, care must be exercised to avoid lacerations; when the head is born, support it until the uterus has time to contract upon the diminished fetal body, and the shoulders are born.

What are the dangers to the mother during the second stage of labor?

Prolonged retardation in the fetal advance, which may result in pressure-slough, eclampsia, rupture of the uterus, laceration of the cervix or perineum, premature placental separation, rupture of varicose veins, apoplexy, or syncope.

Define the third stage of labor, and state its proper management.

It is the stage of *placental expulsion*. In normal cases the uterus contracts after the birth of the child and the placenta is driven into the lower uterine segment. If undisturbed it will remain here for a period of from fifteen to thirty minutes, when, the uterus again contracting, it will be expelled. The hand is to be kept on the fundus uteri from the time of the delivery of the child until the placenta is expelled, in order to avoid uterine relaxation and hemorrhage. Credé's method is not to be applied until at least *twenty minutes* have elapsed since the delivery of the child, unless there are special indications for haste.

Give the character, situation, and cause of the pains during the first and second stages of labor.

During the first stage they are *colicky*, and are at first felt in the small of the back, as a rule. They result from squeezing of the nerve fibers of the uterine muscle. They cause dilatation of the lower segment of the uterus and os. In the second stage they become of a *bearing-down* or *expulsive* character, and are due to the pressure upon the soft parts, as well as upon the uterine nerve-fibers.

Give the differential diagnosis of true from false labor pains.

False labor pains may occur for a period of from two to three weeks before the advent of true labor. They are irregular in location and are not accompanied by dilatation of the os. On the other hand, it is to be remembered that at times during false labor pains the os temporarily dilates and subsequently contracts again, or it may remain considerably dilated until the advent of true labor. One of the most useful points in the diagnosis is the presence or absence of *cervical obliteration*. True labor pains occur intermittently and with progressively increasing severity. They are first felt in the back, as a rule, and later pass around to the abdomen. They result in dilatation of the os and obliteration of the cervical canal.

What precautions should be observed in attending a case of labor?

Aside from the preparation of the armamentarium, the physician should practice and demand from the nurse the most rigid antisepsis and asepsis. Neither should have been in attendance upon a contagious case. If this is unavoidable, an extra degree of caution should be exercised. Rubber gloves give an added protection in all cases of labor.

Describe the duties of the obstetrician during the course of a normal labor.

After assuring himself that the labor is normal, his duty is simply to see that the case continues to progress favorably. All unnecessary examinations should be avoided. The greatest care must be observed to conduct the case aseptically. The perineum must be guarded to prevent severe lacerations. After the delivery of the child, its eyes and mouth must be cleansed, the cord ligated, the placenta delivered and, of course, the uterus must be watched to prevent relaxation. A pad is applied above the fundus with an abdominal binder. The condition of the mother's pulse must be ascertained before leaving the case.

Give a list of articles needed by the physician during labor.

Forceps, scissors, hypodermic syringe, placental forceps; needles and suture material; ligature for cord. Soap and hand-brush, rubber gloves, cotton, gauze packing; douche-bag with intra-uterine nozzle; sterile water; bichlorid of mercury tablets, ether, whisky, and ergot.

How should the first examination of a case in labor be made?

The pelvic measurements should have been taken and the presentation of the child determined before the onset of labor; if not, these facts must

now be ascertained. The examination proper consists in determining the position of the child and its condition, the stage of dilatation, and the condition of the maternal soft parts. First palpate the abdomen, then auscultate for the position and quality of the heart sounds. Carefully sterilize the hands and use gloves. Cleanse the external parts. It is well to make the examination during a labor pain, in order to test its efficiency.

State when a vaginal douche is indicated before, during, and after labor.

No douche before or during labor except in the presence of gonorrhea; no douche after labor unless there is a suspicion of faulty technic in the asepsis. Some give a douche after high forceps operations or version, but many believe this to be unnecessary. The reasons for avoiding the giving of a douche when possible are the great danger of introducing infectious germs, and the fact that the protective vaginal bacteria are removed by the douche. If the lochia become offensive, it is well to give vaginal douches.

Discuss the use of anesthetics during labor.

Not to be employed until the second stage. Chloroform or ether may be used to the stage of analgesia. For surgical operations, as high forceps, etc., the use of ether is to be recommended except in the presence of kidney lesions or marked pulmonary disease, which indicate chloroform. By the administration to the surgical degree a condition of relaxation of the soft parts is produced, the uterine contractions are largely abolished, and there is danger of fetal asphyxia and postpartum bleeding. Spinal anesthesia is still *sub judice*.

What are the uses and dangers of ergot in obstetrics?

Ergot should never be used until the head of the child is born. If used early in labor there is danger that rupture of the uterus or tetanic contractions sufficient to cause the death of the child may be occasioned. It, therefore, should never be used in uterine inertia or exhaustion.

How soon after the birth of the child should the umbilical cord be ligated? How is it to be ligated? How should the cord be dressed and managed?

Do not ligate until pulsations have ceased. Use some sterile material, as silk or tape, and tie in a surgeon's knot about 2 in. from the navel In thick cords it is well to strip before tying. As a dressing *salicylic acid*, 1 part, and *starch*, 4 parts, may be used, the cord being covered with *salicylic cotton*. A binder is applied. The child is not to be placed in the tub until the cord has "fallen."

What are the dangers of traction on the cord?

Traction on the cord may cause premature separation of the placenta. It may cause rupture of the cord or its forcible separation from the placenta; or it may result in inversion of the uterus.

Describe a normal labor in which the vertex is presenting anteriorly and to the left.

The *stage of dilatation* lasts about sixteen hours in primiparæ and about eleven in multiparæ. The *stage of descent* in a primipara lasts about two hours and in a multipara about one hour. The membranes rupture after full dilatation has been effected. At first the small fontanel is found in relation with the left acetabulum, and during descent it gradually rotates until it is under the arch of the pubes. The head engages in flexion and is born by an act of extension. The *placental* or *third stage* of labor lasts about half an hour. The child cries as soon as it is born.

What are the causes of premature rupture of the membranes? How does early rupture influence the progress and conduct of labor?

Undue tenuity, malpresentations, hydramnios, careless examination. Such a labor is designated "*dry*." The results are slow dilatation of the os, an increased tendency to marked cervical tears, and prolapse of the cord.

What instructions should be given a primigravida as to lactation?

The child is to be nursed every two and a half hours. After each nursing the nipple is to be bathed with warm water, dried, and anointed with sweet oil. The nipple must be washed again just before the next feeding, and the baby's mouth cleansed with boric acid solution before it is put to the breast.

What are after-pains? State their cause and give treatment.

Irregular and painful contractions of the uterus, due to attempts on the part of the organ to empty itself of clots or remnants of decidua. They are more marked in multiparæ. In primiparæ the uterine muscle is in a better state of contraction and so there is less clot formation. *Treatment:* Opiates and ergot, or a hypodermic injection of morphin.

Give the causes of dystocia in the uterus, vagina, pelvis, and vulva.

Uterine dystocia may be due to atony or weakness of the muscle, tumors, malformations, abnormal placental attachment, rupture, and malpresentations of the fetus. In the *vagina*, to septa, stenosis or tumors; in the *pelvis*, to contractions or tumors; in the *vulva*, to hematoma, stenosis, imperforate hymen, or tumors.

Give the formation of the caput succedaneum. Where does the caput succedaneum appear in the third position?

The caput succedaneum is the swelling found upon the heads of many children if there has been much moulding of the skull. It is due to a serosanguineous infiltration of the connective tissue of the part. In other words, it is an *edema* of the portion of the scalp not compressed by the maternal structures. In the R. O. P. position it appears upon the left parietal eminence.

What are the antiseptic measures to be employed in the care of a case of labor?

The use of certain chemical antiseptic solutions when necessary; avoidance of unnecessary examinations, which should be as few as possible; the wearing of rubber gloves.

How should a case of labor be conducted to avoid septic infection? What are the sources of septic infection in the puerperal state, and what would be the proper management if infection should occur?

The greatest care in regard to the surgical cleanliness of both doctor and nurse; cleanliness of the patient; thorough asepsis of water, instruments, dressings, etc., used.

If infection has occurred the uterus should be evacuated with the finger, placental forceps, or dull curet, and this should be followed by a douche of weak bichlorid of mercury or normal salt solution. Internally the treatment is stimulative. In rare cases the use of antistreptococcic serum may do good. Various operative procedures are required for certain conditions due to the more serious infections.

Give the mechanism of placental separation and expulsion and the management of this stage of labor.

The placenta, by the contractions of the uterus, is finally converted from a spongy into a solid body. In this state it is "sprung off" the uterine surface and becomes a foreign body upon which the uterus acts by its contractions, driving it into the paralyzed lower uterine segment. Artificial aid is at times required for its delivery. The *management* of this stage consists in the application of *Credé's method of expression* after about twenty minutes have elapsed since the birth of the child. Hemorrhage, from relaxation of the uterus, must always be watched for throughout this stage until the placenta has been delivered and a firm binder has been applied to the abdomen.

Describe the delivery of the placenta by Crede's method.

Apply gentle friction to the fundus until it hardens. Then, with the fingers behind and the thumb in front of the uterus, expel the placenta as one would a stone from a cherry. The pressure is to be made in the axis of the parturient canal, and no expression is to be employed unless the organ is in a state of contraction.

How is a retained placenta to be delivered?

By the use of Credé's method. If this does not succeed, gentle traction on the cord is proper, since the placenta is probably in the relaxed lower segment or in the upper vagina, so that uterine contractions are powerless to expel it. If this does not cause expulsion, the finger is to be introduced and the placenta hooked down. The condition is harmless if relieved in time, while adherent placenta may give rise to postpartum hemorrhage or sepsis.

Give the causes of adherent placenta.

True adherence is rare. The *causes* are endometritis and syphilis. There is usually an excess of connective tissue in the deciduæ, glandular atrophy, and actual penetration of the muscle of the uterus by the villi.

Describe the method of delivery of an adherent placenta at term.

Be sure that it is "adherent" and not simply "retained." Sterilize the hand and arm and introduce hand into uterus to the placental site. Gradually pinch off the placenta, using very little force. The external hand grasps the fundus and stimulates the uterus to contract before the placenta is withdrawn. A hot intra-uterine douche may be given.

Give the causes, diagnosis, and management of uterine inertia.

Weakened uterine force is *caused* by defects in the muscle or in innervation or by some mechanical interferencc with the action of the muscle (rapidly repeated pregnancies, twins, hydramnios, hemorrhage, fatigue, and emotion). Among the mechanical difficulties are fibroids, adhesions, and uterine displacements.

Diagnosis.—Lack of vigorous contractions, lessened severity of pains, delayed labor.

Treatment.—If excessive pain prevents contractions, chloral, morphin, bougies, dilating bags, and forceps. In less severe grades the use of quinin is advocated by some. Small quantities of food with a little alcohol are of great advantage. Ergot is not to be used to promote contractions. Postpartum bleeding is to be guarded against. If the condition is feared, in any case it is well to give strychnin during the last two weeks of the pregnancy.

What injuries may happen to the bladder and rectum during labor and how may they be avoided?

Vesicovaginal fistula, rupture by instruments, or spicules of bone. They are to be avoided by prompt use of instruments and by always catheterizing before applying forceps. The rectum may be lacerated by the presenting part of the child. Avoid by securing proper rotation of the head and a slow perineal stage.

State the dangers and symptoms of a prolonged labor.

The symptoms of prolonged labor are those of uterine inertia. The *fetal* dangers are brain compression and intra-uterine inspiration. *Maternal* dangers are pressure necrosis, sepsis, postpartum hemorrhage, and death from exhaustion.

What is the proper management of rigidity of the os uteri in labor?

The condition is normal in primiparæ. It is found to an exaggerated degree in older patients in their first labors. The treatment consists in the use of copious douches, chloral, an anesthetic, dilating bags, or, very rarely, incisions.

What are the causes of delayed labor (a) on the part of the mother and (b) on the part of the child?

(a) Maternal causes are uterine inertia and obstruction in the birth canal from any cause. (b) The fetal causes are malpositions or malpresentations, oversize, hydrocephalus, fetal syphilis, fetal ascites, and other diseases causing overgrowth of organs and distention of cavities.

What are the causes of precipitate labor? Its dangers and treatment?

Causes.—An abnormally slight degree of resistance of the soft parts or abnormally strong expulsive contractions of the abdominal and uterine muscles. The *dangers* are asphyxiation of the child, rupture of cord, separation of placenta; maternal hemorrhage, uterine inversion, syncope, lacerations.

Treatment.—Administration of an anesthetic and retardation of presenting part.

Name the various conditions which retard or obstruct labor.

Inertia uteri; pelvic deformities; congenital anomalies in uterine development; cervical atresia; infiltration and rigidity; vaginal hematoma, atresia, tumors, and cysts; vulvar tumors and varices; congenital narrowness of the vagina and vulva; rigidity of tissues at outlet in elderly primiparæ. Uterine malposition, either congenital or acquired; sacculation of the uterus; cervical displacement; tumors of the cervix; partial prolapse of the uterus; tumors of neighboring organs. Abnormalities in mechanism; fetal overgrowth; premature ossification of fetal bones; fetal malformations; fetal diseases (cystic tumors and hydrocephalus); fetal malpresentations or faulty positions; multiple births; abnormalities in membranes, liquor amnii, and umbilical cord.

What is meant by prolapse of the funis? When does it occur? What are its dangers? How should such a case be managed?

Prolapse of the cord is the descent of a loop in advance of the presenting fetal part. It occurs in malpositions and malpresentations of the fetus in multiple pregnancy, in hydramnios with sudden escape of the liquor amnii, and in contracted pelves when the presenting part does not occlude the superior strait. The *danger* is death of the fetus from asphyxia due to pressure on the cord.

Treatment consists in replacement of the prolapsed loop by means of the fingers or some form of repositor, the woman being in the knee-chest position. If reposition is impossible, version or a rapid forceps extraction must be done.

Name the accidents which may occur in labor, (a) to the mother, and (b) to the child.

(a) Rupture of the uterus, premature detachment of the placenta, postpartum hemorrhage, eclampsia, bleeding from placenta previa, lacerations of the cervix and perineum, syncope, inversion of uterus.

(b) Prolapse of the cord, asphyxia, fracture of skull, or injuries to brain substance by forceps or birth pressure, etc.

Give diagnosis and treatment of hour-glass contraction of the uterus.

Upper uterine segment contracted upon the placenta, lower segment and cervix dilated; ring thus formed. Manual placental removal under anesthesia.

How would you recognize retention of urine during labor and how after labor? Describe the treatment of each of the above conditions.

During *labor* retention is unlikely, unless the head remains stationary at the outlet for a long time. The condition may be diagnosed by the presence of a swelling just above the pubis. It is always best to pass a catheter before applying forceps. In the *puerperium* this condition is very often found because of the increase in the bladder area made possible by the evacuation of the uterus, the laxity of the abdominal muscles, and the injuries resulting to the urethra during labor. After labor a woman should be catheterized at intervals of about eight hours. The *diagnosis* after labor depends upon the presence of a cystic tumor, dull on percussion, with the subjective sensations of pain if the amount retained is large.

Treatment.—During labor, if there be a considerable quantity retained, as might occur in a retrodisplaced uterus with a resulting sacculation of the bladder, it is necessary to use the male prostatic catheter; or, if this fails, a suprapubic cystotomy would be necessary.

What is episiotomy and when is it indicated?

Episiotomy is the making of lateral vulvar incisions to avoid perineal lacerations of a severe grade. The incisions are made laterally just within the vulva. The operation has an extremely limited field.

Give the method of delivery in twin pregnancies.

Immediately after the delivery of the first child examine the position of the second. Correct any malposition. After waiting about half an hour rupture the membranes and give ergot. Cut the cord of the first child between two ligatures. Apply forceps to the second child if there is any delay.

Name some of the difficulties which may be encountered in twin deliveries.

Malpresentations of one or both twins; impaction of head of the second with the neck of the first; locking of chins; coiling of umbilical cords; difficulties in the delivery of the placenta; postpartum hemorrhage; eclampsia; hydramnios.

What indication would lead you to insert the hand into the uterus, and what are the precautions to be observed?

Failure of the birth of the placenta after waiting a reasonable time and after the employment of Credé's method; active postpartum hemorrhage; the necessity for the performance of version. Most careful aspesis and antisepsis of the hands of the physician; careful cleansing of the external

parts of the patient; and assurance that there is no marked liability to rupture of the uterus. Rubber gloves are an added safeguard.

Describe the technic of intra-uterine irrigation, and state when its employment is justifiable.

This procedure should be carried out with the utmost regard for the principles of asepsis, as harm may readily be done if it is carelessly performed. The external genitalia and the vagina are cleansed, a speculum is inserted into the vagina, and the cervix is grasped with a tenaculum. The intra-uterine catheter is then carried into the cavity of the womb, and the latter is flushed with the prepared solution. The solution may be mercuric bichlorid, formalin, alcohol and glycerin, plain normal salt solution, etc. The indications vary with different obstetricians, some advising the use of an intra-uterine douche after every intra-uterine manipulation, as the performance of version or the application of forceps; while others do not employ it unless there has been some error in the asepsis of these processes. One of its most important indications is puerperal sepsis.

Give the causes and obstetric treatment of lacerations of the cervix uteri.

Causes.—Abortion or miscarriage through a rigid cervix; precipitate delivery; oversize of the fetal parts; instrumental delivery before the head has escaped from the cervix.

Treatment.—If there is no marked bleeding from the tear, nothing need be done. If there is hemorrhage, a suture should be introduced. Some advise immediate cervical repair, or its repair before the end of the puerperal period.

Describe symphysiotomy and give the indications for its performance.

The operation has but a very limited field. As a rule the indications for this operation are better met by the performance of Cesarean section. The operation comprises section of the symphysis pubis, which allows a diastasis of the pelvic bones to occur, the child being extracted through the natural passages. It is to be looked upon as an alternative to version and should only be employed in cases in which the conjugate diameter is 7 cm. or more. The best *method* is the so-called "*indirect,*" in which the skin is incised above the symphysis and the bones are separated by a section through the joint by cutting from behind forward and from below upward. The child is extracted with forceps, great care being exercised to support the lateral halves of the pelvis while extraction is being performed. After the delivery the pelvis is supported by the application of a firm binder.

What are the complications in obstetrics which justify an abdominal section?

Conditions indicating a Cesarean section, as contracted pelvis; rupture of the uterus, retrodisplacement of the uterus with incarceration, extra-uterine pregnancy, labor complicated by tumors, grave septic infection of the uterus, septic infection of the adnexæ or broad ligaments (the last three are but seldom true indications for section).

Define hysterectomy and state its indications.

Hysterectomy is excision of the uterus. In obstetrics it may be indicated in rare instances of septic infection (usually when the diagnosis warrants this operation the case is beyond hope), in rupture of the uterus, and in rare cases of uncontrollable postpartum bleeding. In certain cases of Cesarean section the removal of the uterus is indicated.

Define Porro's operation, state when it is applicable, and describe the method of its performance.

The so-called Porro operation is the performance of a *supravaginal hysterectomy after the uterus has been evacuated by a Cesarean section.* Its indications are those conditions which would make the repetition of the operation of Cesarean section necessary for subsequent delivery (such as extreme degrees of pelvic contraction, bony tumors in the pelvic canal or myomatous tumors in the lower segment of the uterus, extensive ruptures of the uterus, a septic condition of the uterus, or a very flabby uterus with uncontrollable bleeding). Its performance is identical with that of Cesarean section until the child has been removed, the subsequent steps being those of an ordinary amputation of the womb.

Give the conditions requiring Cesarean section, and describe Sänger's modification.

The conditions are (a) *absolute* and (b) *relative.* Under the former may be classed severe grades of pelvic contraction and deformity, as well as foreign growths obstructing the pelvis, cicatricial contractions of the vagina, and carcinoma of the cervix or rectum. Under the term *relative indications* may be included cases in which there are other possible methods of delivery, but in which there seems to be a better outlook for the case if Cesarean section is performed. This is exemplified in cases of less severe contractions of the pelvis in which, while there is no doubt that by symphysiotomy or craniotomy or even a hard forceps operation the child might be delivered, there is little hope of its survival.

The original operation, that of Porro, is now generally modified after the technic of *Sänger.* The abdominal incision is made, the uterus is delivered, towels are packed behind it, and the opening into the uterus is made by incision instead of by tearing. The child and placenta are then removed and the uterine wound sutured in three layers: one interrupted suture of the wall, one continuous of the wall, and one continuous suture uniting the peritoneum. The abdominal wound is then closed.

Define embryotomy and craniotomy, and give the indications and the operative method for the performance of each.

Embryotomy is a mutilating operation upon the fetus. It is a generic term, and includes craniotomy, decapitation, evisceration, and amputation of the extremities.

Craniotomy is the operation in which the head is perforated and its contents evacuated, the head being thus diminished in size. The forcible extraction of the head is often also a part of the operation.

Indications may be found in both dead and living children. In the former they may be any condition which retards labor if by the performance

of the operation the mother may be saved suffering. In only the most exceptional cases is the operation indicated when the child is alive.

Technic of Craniotomy.—Vaginal asepsis; fixation of the head and scalp with Volsella forceps; perforation through suture or fontanel; enlargement of the perforation; evacuation of the brain-mass; extraction of the head with the cranioclast.

Give the various steps in the performance of embryotomy in the transverse presentation.

Attempts should be made to alter the position in order to reach the head. If impossible, fix the most dependent part with double tenaculum forceps and evacuate the body cavities or amputate the head, as the case may be. After amputation of the trunk it may be necessary to perform craniotomy in order to deliver the head.

What are the methods employed in obstetrics for the dilatation of the cervix?

Manual methods by the use of the fingers: Edgar's and Harris's.
Dilating Bags.—Champetier de Ribes' and Voorhis'.
Instrumental.—Hegar's, Bossi's dilators.
Operative.—Incisions, and Dührssen's so-called Cesarean section.

When is accouchement forcé indicated and how is it performed?

True indications are rare. They may arise in eclampsia, placenta prævia, premature detachment of the normally situated placenta, and heart disease. The methods are the *manual*, the *instrumental* (Bossi, Frömmer, Hegar), and the *operative* (incisions, or Dührssen's Cesarean section).

What procedure would you employ in case the fetal head failed to engage?

According to the cause, there might be indications present for the application of the axis-traction forceps, version, possibly symphysiotomy, Cesarean section, or even craniotomy.

Is the induction of premature labor ever justifiable? If so, when and how would you perform the induction?

It is justifiable whenever danger to the life of either mother or child can be averted by its use, and whenever, with moderate degrees of pelvic contraction, a severe labor with possible grave operative interference can be avoided.

The more common *indications* are contracted pelvis of minor grades, toxemia of pregnancy of a severe degree, certain cases of habitual death of the fetus just before term, selected cases of heart disease and tuberculosis.

The most satisfactory *method* is the introduction of a sterile bougie in conjunction with a dilating bag. In certain conditions a rapid evacuation of the uterus may be necessary, and to meet this indication the cervix may be rapidly dilated by the manual methods, by the Bossi dilator, or it may be incised, as in Dührssen's Cesarean section. Often a combination of the methods of Bossi and Dührssen will best meet the indication.

What pelvic measurements indicate the induction of premature labor?

A conjugate diameter of 9.5 cm. or less in a pelvis of the type of "simple flat," "rachitic flat," or "generally contracted." If the diameter is much below 8 cm., induction is not advisable.

Define version. Give the varieties, indications, and dangers of version, together with the preliminaries and the method of operating.

Version or turning means the change of the position of the fetus *in utero.* The *varieties* are (a) *postural external* (by abdominal manipulations alone), (b) *combined* (one hand acting externally and the other internally), and (c) *podalic* version (grasping of a foot by the internal hand), which is the one most often employed.

Indications: Transverse position of fetus; contracted pelvis; premature separation of the placenta, eclampsia, rupture of the uterus, sudden death of the mother, or any other condition in which, with an unengaged head, there is an indication for very rapid delivery; placenta prævia; prolapse of the cord.—The *dangers* are: for the *mother*, an increased liability to sepsis, rupture of the uterus, and embolism; for the *child*, death from asphyxia, intracranial injuries, and fractures of the clavicles or extremities.

Method.—In preparing for the operation it must always be ascertained that engagement has not taken place, and that there is no danger of rupture of the uterus as a result of the interference (the contraction ring should not have markedly ascended). The woman is placed upon the side toward which the fetal limbs point; the hand is introduced which, when held midway between pronation and supination, corresponds with its palmar surface to the abdomen of the child; the other hand, or that of an assistant, is placed upon the fundus uteri; the anterior foot is then grasped with the fingers of the internal hand and, the woman being now upon her back, the version is accomplished by a combination of traction with the internal hand and a lifting of the presenting part out of the pelvic inlet with the external hand. At the same time the assistant may give great aid by pushing the breech toward the side upon which the feet were placed originally. When the knee is born all attempts at traction should cease, unless the case is one demanding immediate delivery, and the natural pains should be allowed to effect delivery until the points of the scapulæ appear under the symphysis; the arms and head must then be promptly delivered to avoid fetal asphyxia.

Describe in detail the operation for the immediate repair of a complete laceration of the perineum.

Cleansing of the wound. Suture of the lateral tears, if any, of the sulci. Repair of laceration of the rectovaginal septum. Introduction of sutures through the severed ends of the sphincter muscle; these sutures pass through the end of the muscle on one side, then to the top of the tear in the rectovaginal septum, and then emerge in the opposite side after passing through the other end of the sphincter muscle. At least two of these muscle sutures are needed. When they are shotted they should disappear in the rectum. Closure of the external perineum by interrupted sutures. The material used for sutures should be silkworm-gut.

What structures enter into the formation of the pelvic floor?

From without inward: the transversus perinei, the ischiocavernosus, the sphincter ani, the sphincter vaginæ, the coccygeus, and the levator ani muscles, together with the pelvic fascia.

Describe and give the functions of the perineal body.

It is formed by the junction of the following structures: the two superficial and the two deep transverse perineal muscles, the bulbocavernosus muscle, the constrictor vaginæ muscle, fibers of the levator ani muscle, and fibers of the sphincter ani, together with the deep layer of the superficial fascia and the triangular ligament. Its *functions* are to act as a fixed point of anchorage for the structures of which it is composed and thus to aid in the support of the pelvic contents.

What is the perineum? How is it endangered in labor, and how should it be protected?

The perineum, in the obstetric sense, is the pelvic floor. It is composed of muscular and fascial structures (see preceding question). The levator ani is the most important muscle. During the passage of the head over the perineum the muscular and fascial elements are stretched and often torn. By a proper technic bad tears are avoidable in the greater number of cases. The usual *causes* of bad lacerations are disproportion between the head and the outlet, imperfections in the mechanism of expulsion, and precipitate delivery. *Prevention* of severe tears is accomplished by retardation of the head, by pressure upon it as it appears at the outlet, or by lifting it away from the perineum upward toward the symphysis pubis. This later maneuver is performed by placing the hand with its palmar surface against the perineum and allowing the head to make its appearance gradually between the thumb and index finger, which are placed on each side of the outlet. The short forceps and the method by rectal expression are sometimes of value. The latter must be used with the greatest antiseptic precautions to avoid infection.

What are the late results of a laceration of the perineum?

If the levator ani is the seat of the laceration, there will be a loss of support with the development of a *cystocele* and *rectocele*, a probable backward displacement of the uterus, and *prolapse* in one of its grades. There will also be symptoms of catarrhal inflammation of the endometrium in many cases, due to the chronic congestion. There may also be a prolapse of the ovaries. The *symptoms* will be backache, headache, bearing-down pains in lower abdomen, reflex nervous symptoms, increased leukorrhea, and menstrual disturbances. Any or all of these symptoms may be absent.

Give a description of cystocele and rectocele. State how they may complicate labor, and what should be done in the emergency.

A *cystocele* is the result of lacerations of the pelvic floor and consists in the prolapse of the posterior bladder wall with a consequent protrusion of the anterior vaginal wall through the introitus vaginæ. A *rectocele* has the same etiology and is a prolapse of the anterior rectal wall with a con-

sequent protrusion of the posterior vaginal wall through the vaginal entrance. In rare cases the condition may cause retardation of the advancing head, which must be met by attempts at replacement, followed by the application of the forceps if replacement fails.

PELVIMETRY

Name the various diameters of the fetal head.

Bitemporal	8 cm.
Biparietal	9¼ cm.
Bimastoid	7⅝ cm.
Occipitofrontal (from the root of the nose to the external occipital protuberance)	11¾ cm.
Occipitomental (from the point of the chin to the external occipital protuberance)	13½ cm.
Suboccipitobregmatic (from the central point of the bregma to a point midway between the occipital protuberance and the foramen magnum)	9¾ cm.
Frontomental (from the top of the forehead to the point of the chin)	8 cm.
Trachelobregmatic (from the central point of the bregma to the anterior margin of the foramen magnum)	9½ cm.
Mentobregmatic or cervicobregmatic (from the central point of the bregma to the junction of the chin and neck)	9½ cm.

Give the obstetric landmarks of the superior and inferior straits.

Superior Strait.—The four cardinal points are the sacro-iliac synchondroses, the iliopectineal eminences, the sacral promontory, and the iliopectineal line.

Inferior Strait.—Bounded by the tip of the coccyx, the ischial tuberosities, and the subpubic angle.

Name the bones, divisions, straits, and symphyses of the pelvis from the standpoint of obstetrics.

The pelvis is composed of the *two innominate* bones, the *sacrum* and the *coccyx;* it is divided into the *true* pelvis below, and the *false* pelvis above the iliopectineal line. This line forms the boundary of the *inlet* or *superior strait.* The lower outlet of the bony pelvis is called the *inferior strait.* The symphyses are three in number, namely, the *pubic* and the two *sacro-iliac.*

Give the diameters of the pelvic outlet. How is the outlet bounded?

The *transverse* (between the ischial tuberosities) 11 cm., and the *conjugate* (between the tip of the coccyx and the subpubic ligament) 9½ cm. at rest, and 11 cm. in labor. The pelvic outlet is *bounded* by the tip of the coccyx, the ischial tuberosities, the sacrosciatic ligaments, the thyroid foramina, and the subpubic ligament.

Give the relations of the cephalic and pelvic diameters at three points during the birth of the head in an L. O. P. presentation.

At the superior strait the occiput is in relation with the left sacro-iliac joint and the circumference of the head, corresponding to the suboccipitobregmatic diameter, is in relation with the superior strait. The sagittal

suture lies in the left oblique diagonal. In the pelvic excavation, if rotation has occurred, the occiput is in relation with the great sacrosciatic foramen. The sagittal suture being transverse at the outlet of the pelvis, the occiput is under the pubic arch, the parietal eminence being opposed to the rami of the pubes, while the sagittal suture lies anteroposterior.

Name the pelvic malformations. Give the differential diagnosis and the treatment of each.

(a) *Simple Flat Pelvis.*—Anteroposterior diameter lessened; sacrum pressed downward and forward, but not rotated on its transverse axis; other diameters approximately normal.

(b) *Generally Contracted Pelvis.*—All diameters lessened.

(c) *Rachitic Flat.*—All diameters lessened, but the contraction most marked in the anteroposterior; sacrum rotated on its transverse axis, pressed downward and sharply bent transversely; interspinous diameter approaches or exceeds the intercristal. In the above types of deformity the following rules hold good with respect to treatment: 1. If the conjugate is not below 9.5 cm., labor may be induced from two to four weeks before term. Forceps, version, symphysiotomy or Cesarean section at term may be required. 2. If the conjugate is between 7 and 9.5 cm., induction of labor at the thirty-sixth week. 3. If the conjugate is 7 cm. or less, allow the case to go to term and perform a Cesarean section.

(d) *Funnel-shaped Pelvis.*—Diameters of outlet decreased; depth increased. If the transverse diameter of the outlet measures 7.5 cm. or more the best treatment is a symphysiotomy. Higher grades of contraction demand a Cesarean section.

(e) *Naegele Pelvis.*—Unilateral want of development of the sacral alæ. In marked grades of the deformity a Cesarean section is demanded, but in less severe types induction of labor will suffice.

(f) *Robert Pelvis.*—Bilateral want of development of both sacral alæ. Cesarean section indicated.

(g) *Osteomalacic Pelvis.*—Due to a general softening of the bones of the pelvis, diminution in height; pressure in acute cases will demonstrate the flexibility of the bones, as does also the loss of the normal pelvic conformation. *Treatment:* Porro-Cesarean section.

(h) *Spondylolisthetic Pelvis.*—Last lumbar vertebræ dislocated in front of sacrum, which is rotated backward; lordosis of the lumbar vertebræ; anteroposterior diameters diminished; inclination of the pelvis disturbed; orifice of the vulva directed anteriorly as the patient stands. *Treatment:* identical with that in simple flat pelvis.

(i) *Kyphotic Pelvis (Hump-back).*—Sacrum rotated backward; inlet enlarged in anteroposterior diameter, while the pelvic outlet is contracted in the transverse. *Treatment:* If the transverse diameter of the outlet does not measure under 8.5 cm., allow the case to go to term; if between 8.5 and 6 cm., induce labor at the thirty-sixth week; if less than 6 cm., Cesarean section is indicated.

What difficulties arise during labor from malformations of the maternal pelvis?

If the pelvic measurements are decidedly above normal (justomajor), a precipitate labor may result, with damage to the maternal soft parts

and possible danger to the child. If below normal, various degrees of retardation occur, with increased severity of pains, rise of the contraction ring, malposition of the presenting part, and rupture of the uterus may follow. Compression of the fetal head and, in neglected cases, sloughing of the maternal soft parts are sometimes encountered.

What is the axis of the superior strait and what is its relation to the axis of the body?

A line passing through the center of the plane of the superior strait in a direction perpendicular to this plane. One end of such a line will, if the projection is carried out, strike the umbilicus, while the other end will impinge upon the middle of the coccyx. The direction of the axis is, therefore, downward and backward. The plane of the superior strait forms an oblique angle with the axis of the body.

What is the axis of the inferior strait?

A line at right angles to the plane of the inferior strait passing through its center. It is represented by a line which, if carried up, would touch the base of the sacrum.

Differentiate the planes and axes of the pelvis and mention their obstetric importance.

The plane of the superior strait forms an angle of 50° to 60° with the horizon and is obliquely placed with reference to the spinal column. The plane of the inferior strait forms an angle of 10° with the horizon. The axis of the pelvic canal is represented by a line passing through the center of each plane, parallel to the sacrum. Variations in the pelvic direction may be the cause of decided difficulties in labor.

Give the names and dimensions of the diameters of the pelvic inlet.

True conjugate (anteroposterior), 11 cm.; *transverse*, 13.5 cm.; *oblique* (right and left), 12.75 cm.

Differentiate the male from the female pelvis. What is the importance of these differences in labor?

Male.—Bones heavier; cavity contracted. Sacrum narrow and curved. Ischial tuberosities closely approximated. Subpubic arch narrow. Pelvic brim triangular. Pelvic inclination slight. Thyroid foramen oval.

Female.—Bones lighter; cavity roomy. Sacrum wide and more deeply curved. Tuberosities of the ischium more widely separated. Subpubic angle widened. Pelvic brim cordate. Thyroid foramen triangular.

MECHANISM OF LABOR

What is meant by the 'mechanism of labor'?

The manner in which the fetus and its appendages traverse the birth canal and are expelled.

Name the forces which occasion normal delivery.

Contractions of uterine, abdominal, and pelvic floor muscles; resistance of the lateral pelvic walls and pelvic floor.

Describe the mechanism of expulsion in natural labor.

Expulsion is dependent upon the force exerted by the uterine and abdominal muscles, together with the forces of resistance contributed by the lower uterine segment, the cervix, vagina, pelvis, and fetal body. By the contraction of the uterine and abdominal muscles the intra-uterine space is diminished, and the fetus is expelled in the direction of least resistance.

State the causes of dilatation of the os and cervix uteri during labor.

The wedge-like action of the bag of waters upon the edematous cervical tissues, and the upward traction of the longitudinal muscle fibers of the uterus.

What is the 'bag of waters,' its functions, and management during labor?

It is the elastic membrane which contains the liquor amnii.—Its functions are to protect the fetus during pregnancy and to distend the os during labor. It should never be ruptured artificially in primiparous labors, and in multiparæ only after full dilatation has been secured.

Describe the mechanism of labor in L. O. A. presentation.

(a) Accommodation of size of fetal skull to size of pelvic inlet by flexion; accommodation of shape of fetal skull to shape of pelvic inlet by moulding; accommodation of the direction of the head to the direction of the pelvic canal by lateral inclination. (These occur previous to labor.) Further flexion, moulding, and inclination in the early stages of labor. (b) Dilatation of the lower uterine cavity and cervical canal. (c) Descent of the head to the pelvic floor. (d) Anterior rotation of the occiput. (e) Propulsion and extension of the head in the direction of least resistance under the pubic arch, until it is delivered. (f) Restitution. (g) External rotation. (h) Descent, rotation, and birth of shoulders. (i) Delivery of the remainder of the body.

What is the diagnosis of a head presentation?

By abdominal examination the head is found as a hard body at the superior strait, while vaginal examination reveals a dome-like protrusion of the vault of the vagina. The fetal heart sounds are heard below a line passing transversely through the navel.

Give the diagnosis of a presentation of the vertex.

By abdominal examination the fetal head is found in the pelvic brim. By vaginal examination the small fontanel is identified as the lowest point of the presenting part, the sagittal suture running from it toward the anterior fontanel, which in well-flexed heads can be felt only with difficulty.

Give the normal vertex presentations in the order of their frequency.

L. O. A., left occipito-anterior; R. O. P., right occipito-posterior; R. O. A., and L. O. P.

Name the different positions of the vertex. Which is the most usual?

L. O. A. (most usual), R. O. P., R. O. A., and L. O. P. After engagement a posterior occiput may be rotated backward into the hollow of the sacrum.

Give the cause of cephalic presentations, and state why vertex presentations are favorable.

The assumption of the position by the fetus because greater comfort and room for development are afforded. The cephalic extremity is the heavier and so is influenced by gravity, and as a rule the fetus is forced to take the longitudinal position because of the fact that the uterus develops in its perpendicular axis.

Vertex presentations are favorable because the small diameters of the head are offered to the pelvis of the mother.

Describe the difficulties which arise during labor from malpositions of the fetal head.

In general it may be considered that labor under these conditions will be much more difficult and the chances of loss of the child greater than in normal positions. In addition it is to be remembered that a presentation of the face or brow may render spontaneous delivery impossible. A very markedly extended head at the brim may also cause an insurmountable obstacle to natural delivery.

Describe in detail the proper treatment when the head is movable above the superior strait and will not engage.

The difficulty is probably due to contraction at the inlet. After a sufficient time has elapsed to allow for moulding, if engagement is still absent, the axis-traction forceps must be applied, or version performed, depending on the special demands of the case. Extreme grades of deformity demand Cesarean section.

How should a case of lateral presentation be treated?

Manual replacement, converting the presentation into a true vertex presentation. If this is impossible, forceps may be tentatively applied or podalic version performed.

Name the possible presentations of the fetus at term with the positions pertaining to each.

Head Presentations.—Vertex, anterior fontanel, brow, and face.
Vertex: L. O. A., R. O. P., R. O. A., L. O. P.
Brow: R. F. P., L. F. A., R. F. A., L. F. P.
Face: R. M. P., L. M. A., R. M. A., L. M. P.
Breech Presentations.—L. S. A., R. S. P., R. S. A., L. S. P.
Shoulder Presentations.—L. Scap. A., R. Scap. P., R. Scap. A., L. Scap. P.

Differentiate the positions of the fetus at term as determined by external palpation.

Cephalic or *head* presentations show the fetal ellipse lying longitudinally, with the fetal back to one or the other side, the extremities being upon the opposite side, while the hard cephalic extremity is felt at the pelvic brim. In *pelvic* presentations the above conditions are reversed; there is an absence of the hard cephalic mass at the inlet, it being found in the upper portion of the abdomen. In *transverse* presentations the long axis of the fetus lies at right angles to the long axis of the maternal body and low down, near the symphysis; the extremities of the fetus can be easily palpated.

How many different presentations are liable to be met with in obstetric practice?

Three of the fetal body, viz.: the *cephalic*, the *pelvic*, and the *transverse*. The cephalic include the vertex, face, bregma, brow, ear, and parietal eminence. Those of the pelvis include the breech, knee, and foot. The transverse are converted into shoulder presentations when labor occurs.

Define and differentiate position, presentation, and rotation.

Position means the varying relationship existing between the most prominent point of the presenting part of the fetus and the maternal pelvis; or the relation between the long axis of the fetus and the long axis of the maternal body. By *presentation* is meant that portion of the fetal body which is detected by the examining finger at the center of the plane of the superior strait. *Rotation* is the turning of the presenting part toward the front by its impinging upon the pelvic floor. *External rotation* is caused by the engagement of the shoulders and their rotation, and is the turning of the head, after its escape from the vulva, toward the side of the pelvis to which it originally pointed.

Define attitude.

Attitude designates the relation which the various parts of the fetus bear to each other.

What are the positions and attitudes of the fetus in utero, and what are their causes?

The fetus may lie at right angles to, or parallel with, the long axis of the body of the mother. In rare cases it may lie obliquely in the case of tumor or thickening of the uterine wall, or if the uterine cavity is irregular in outline. The causes of shoulder presentation are abnormalities in shape and position of the uterus (pendulous abdomen, multiple pregnancy), conditions preventing engagement of either pole of the fetus (deformed pelvis), and abnormal mobility of the fetus. The causes of breech presentation are abnormalities in the shape of the fetus or of the uterine cavity, while the cause of the assumption of the vertical position *in utero* is the better chance given for development and exercise.

How is a posterior position of the occiput to be diagnosed and managed?

The R. O. P. is the more common position. In this position the small fontanel is to the mother's right side and is in relation with the sacro-iliac

synchondrosis; the sagittal suture will be found in the right oblique diameter, and the large fontanel is in relation with the left acetabulum.

Treatment in the largest proportion of cases consists in placing the woman on the side toward which the fetal back is directed. This is done to secure good flexion of the head and thus to prevent backward rotation of the occiput. If in spite of this, rotation is not accomplished, it will be proper to apply forceps, removing them and reapplying, if necessary, after the head has rotated to an anterior position.

Why are occipito-posterior positions less favorable for delivery than the anterior positions?

Because of the greater distance that the head has to rotate to reach the anterior position necessary for delivery. This causes a prolongation of labor and greater dangers to the child.

Before engagement, how should an L. O. P. be converted into an L. O. A. position?

By securing good flexion. If this fails, draw the occiput down and turn it forward manually. Administer ether, lift the head out of the pelvis, flex and rotate the occiput forward, and push it into the pelvis, holding it in its new position until it is fixed by the pains.

Give the diagnostic points of position R. O. P., determined by abdominal and vaginal examination, and describe the normal mechanism of labor for this position.

Abdominal: Fetal heart-sounds heard on the right side of the mother, toward the flank, fetal back on the right, and extremities on the left side of the mother. *Vaginal:* the small fontanel toward the right sacro-iliac joint; the sagittal suture in the right oblique diameter of the pelvis.

Mechanism: The same as in anterior positions of the vertex, including anterior rotation of the occiput under the pubis. Because of the prolonged rotation of the occiput the shoulders rotate through a third of a circle at the superior strait. Pain is greater and labor is more prolonged than in anterior positions of the vertex.

How would you diagnose and deliver an occiput in the hollow of the sacrum?

The small fontanel will be felt in the posterior part of the pelvis in the median line, while the large will also be in the median line, but high up. The ears may be palpated to render the diagnosis certain.

The *treatment* is to apply forceps as soon as the diagnosis is made. Apply to the sides of the head and gradually elevate the handles until the perineum is about to tear, when they are to be depressed, and the head delivered by extending it.

Give the mechanism and management of a brow presentation.

The most dangerous of all presentations to both mother and child. All the largest diameters of the head are presenting at the superior strait. The *mechanism* is the same as in a face presentation. If the chin is directed

posteriorly, progress is impossible. *Treatment:* Convert into a vertex (by external pressure or by internal and external manipulation). If impossible, then convert into a face if the chin is anterior. If this is not possible, then version. If the chin is anterior and firmly fixed in the pelvis, forceps usually will deliver; if the chin is posterior and conversion into a vertex position, performance of version and rotation are all impossible, a craniotomy is indicated. Never use forceps as tractors in face or brow presentations with the chin posterior.

Describe the management of labor in a presentation of the anterior fontanel.

The malposition of the head should be immediately corrected by pulling down the occiput with the fingers or by pushing up the brow while pressure is made upon the occiput from above through the abdominal walls.

Make a diagnosis of transverse presentation and state how it should be managed. Give the frequency, causes, mechanism, and management of such a case.

By abdominal examination the fetus is found in a transverse position. Heart-sounds low down above the symphysis. Digital examination shows the anatomic landmarks of the shoulder, namely: axilla, clavicle, spine of the scapula, head of the humerus, and ribs. The *treatment* is a podalic version.

The *frequency* is $\frac{1}{2}$ per cent. of all labor cases.

The *causes* are abnormalities in shape and position of the uterus; conditions preventing engagement of the presenting part; abnormal mobility of the fetus. There is no mechanism. In rare cases delivery may be effected spontaneously by spontaneous version, spontaneous evolution, and by a doubling up of the body (*corpore reduplicato*).

Give the differential diagnosis between a vertex and a breech presentation.

By vaginal examination the presenting part, if a breech, is found to be "high" in the pelvis; the presenting part is irregular in shape, and does not present the hard sensation given by the head; no sutures or fontanels are felt; after rupture of the membranes the external genitalia can be distinguished, together with the anus, the gluteal folds, and the leg bones.

By abdominal examination the head will be found under the ribs, the heart sounds above the navel.

What are the dangers of a breech presentation?

Death of the child from asphyxia and severe injury to the soft parts of the mother because of necessary haste in the delivery.

Give the frequency, causes, prognosis, treatment, and dangers of pelvic presentations from the side of the fetus.

Frequency at term is 1.3 per cent. In premature cases the presentation is more frequent. The *cause* is any condition which prevents the entrance of the head into the lower uterine segment, as any abnormality in the shape of the fetus or uterine cavity. The *fetal prognosis* is bad (about 30 per cent.

mortality) because of the dangers of head injury or asphyxia. The *treatment* is expectant, in the absence of symptoms of maternal or fetal danger, until the lower ends of the scapulæ appear, when prompt delivery must be effected to avoid fatal asphyxia.

Describe the management of a breech presentation.

Preserve the membranes as long as possible. When the breech is born, support it and wrap it in hot sterile towels. At frequent intervals examine the cord to see that there is no traction upon it and that its pulsations are good. As soon as the points of the shoulders appear at the vulva, institute measures to deliver the after-coming head.

What is the management of an impacted breech presentation?

Decompose it by bringing down one leg; if this does not succeed, the hand, fillet, forceps, or, in the case of a dead infant, the blunt-hook may be used.

Name the face and breech presentations of the fetus.

The face presentations are: (1) L. M. A. (left mento-anterior); (2) R. M. A.; (3) R. M. P.; (4) L. M. P. The breech presentations are: (1) L. S. A. (left sacro-anterior); (2) R. S. A.; (3) R. S. P.; (4) L. S. P.

Describe three methods for the delivery of the after-coming head.

As soon as the points of the shoulders appear at the vulva it is time to interfere, as there is beginning compression on the cord and delivery must be completed within about five minutes in order to save the child alive.

(1) The first portion of the delivery is concerned with the arms. Grasp the feet in one hand and carry them forcibly up and to the side, at the same time hooking down the posterior arm by sweeping it across the face. Repeat the maneuver to deliver the other arm, and then proceed to the delivery of the head by placing the child upon the forearm, with its legs hanging down on each side. Introduce the index finger of this arm into the child's mouth, and place the other hand on the woman's abdomen. Deliver by making traction on the child's jaw, at the same time carrying the body upward and making pressure above the pubis.

(2) If this method is not successful, quickly pass a finger up under the symphysis and by pushing up the occiput bring about flexion of the head, while making traction as before on the child's lower jaw.

(3) If this also fails to effect delivery, grasp the child by the feet and shoulders and make traction, first downward and then in an ascending curve. If possible, have the assistance of suprapubic pressure in all these methods. If none of them proves successful, apply forceps.

How may the knee be distinguished from the elbow when presenting?

The knee is rounder and larger than the elbow; the popliteal space may be felt in the case of the knee and there is an absence of the sharp, bony

prominences which are felt when the elbow presents; the arm may be readily brought down, while the leg offers more difficulty.

How should a hand presentation be managed? What course would be indicated if an arm were found projecting from the vulvar orifice?

Apply a tape to the arm and then perform a podalic version. The tape is applied in order to prevent extension of the arm above the head.

Give the frequency, cause, mechanism, and treatment of face presentation in the L. M. A. position.

The *frequency* is less than 0.5 per cent.

The *causes* of this presentation are: (1) conditions preventing flexion, as tumors of the neck, increased size of the thorax, coiling of the cord around the neck. (2) Conditions favoring extension, as mobility of the fetus, dolichocephalic head, tumors on the back. (3) Anything that interferes with the entrance of the head into the pelvis, as overgrowth of the child, pelvic deformity.

The *mechanism* consists in full extension and moulding; descent of the chin to the pelvic floor; anterior rotation to the symphysis, under which it lodges; and birth of the head by flexion. This process will be comparatively easy if the chin is anterior, as rotation can occur; but if the chin is posterior, some interference will be needed.

The *treatment* consists in securing good extension of the chin if it is *anterior*, with very careful traction by the forceps if advance ceases. If the chin is directed *posteriorly*, the forceps (straight) may be used to rotate it forward; but they must never be used as tractors on a posterior position. If conversion of a face into a vertex for the purpose of performing version and rotating the chin have all failed, a *craniotomy* is to be done.

How is a face position diagnosed and what is the mechanism of delivery?

By abdominal palpation there is found a mass (the cranial vault) in one hypogastric region, and a groove between the occiput and back may often be made out. By vaginal examination a "high" position of the presenting part is found, with flattening of the vault of the vagina; the smooth outline of the fetal forehead is in contrast with the irregular face. As soon as the os is dilated, the features may be made out—the orbital ridges, the eye sockets, the chin, and the gums. This presentation is often mistaken for the breech, the most important distinctive feature being the gums, hard and resisting, instead of the soft membrane of the rectum.

The *mechanism* is extension—every face presentation is first a brow, and only becomes a face under the influence of the expulsive pains of labor; moulding—confined to the back of the skull, as the face proper is a loose fit in the pelvis; lateral inclination; descent of the presenting part by extension of the chin and not by descent of the head as a whole; anterior rotation of the chin as soon as it reaches the resistance of the pelvic floor, followed by engagement of the chin under the symphysis; delivery of the head by flexion.

What is the mechanism of a mento-posterior position and what are the complications?

A persistent posterior position of the chin renders labor impossible. There is, therefore, no mechanism. Rotation must occur if labor is to advance, and the chin must strike the pelvic floor in order to produce rotation. The difference between the length of the neck and the depth of the lateral pelvis demands that the occiput and the thorax of the child enter the pelvis simultaneously, which is impossible

The *complications* are: tetanic contraction of uterine muscle, impaction of head and shoulders. Death of the child and rupture of the uterus follow in neglected cases.

How may a face presentation be converted into a vertex presentation?

Before labor begins, or in its early stages, the face presentation may be converted into one of the vertex by *external manipulation* (method of Schatz); by combined pressure upon the breech—by an assistant—and upon the thorax and occiput the fetal body is flexed, and flexion of the head is secured. If this plan fails, the methods of Baudelocque (*internal* and *external manipulation*) should be tried. In this operation the chin is pushed up by the internal hand, while the occiput is pressed down by external pressure; or the occiput is pulled down by the internal hand, while external pressure flexes the child's body. If both of these methods fail, the attempt to deliver by the vertex must be abandoned.

What is a compound presentation? How should a presentation of head and arm be managed?

The presentation at the same time of two fetal parts, as the head and a hand.

The cause is usually a lack of conformity between the presenting part and the inlet.

Before rupture of the membranes an attempt should be made to rectify by postural treatment. After the membranes have ruptured, an attempt should be made to replace the prolapsed extremity. If both methods fail, then version or possibly craniotomy must be performed.

Describe the fetal head at full term and give the diagnostic value of the various sutures and fontanels.

The fetal head consists of the base of the skull, the face, and the cranium. The cranium, or yielding portion of the head, comprises the two frontals, two temporal, two parietal, and the occipital bones. The various bones of the cranium are separated from each other by the *frontal*, the *coronal*, the *sagittal*, and the *lambdoidal* sutures. At the junction of the lambdoidal and sagittal sutures, the *small fontanel* is formed, while the meeting-point of the frontal, coronal, and sagittal forms the *anterior fontanel*. The posterior fontanel is small and triangular, while the anterior is larger and kite-shaped.

By the various relations assumed by the sutures and fontanels with regard to the fixed points of the maternal pelvis, the different positions of the presenting head are determined.

INSTRUMENTAL DELIVERY

Give the etymology and uses of the forceps, and name the indications for their employment, together with the rules therefor and precautions to be observed in the same.

"Forceps" is derived from the Latin "forceps," a pair of tongs. It is an instrument consisting of two blades and two handles, united at the shoulder by a lock.

The *indications* for the use of forceps are uterine inertia, minor degrees of pelvic contraction, threatened danger to mother or fetus, and, rarely, the correction of malpositions of the fetal head.

Necessities for its employment are: dilated os, ruptured membranes, absence of marked disproportion between the head and birth canal. The presenting part should, as a rule, have engaged, and labor must not be "impossible."

The *left* blade is first introduced, being held in the *left* hand and introduced into the *left* side of the maternal pelvis. The blades must be applied to the sides of the child's head (except in applications at the superior strait) by rotating the blade corresponding in name with the diameter of the pelvis in which the child's head lies. Thus, in applying to a head in the L. O. A. position, the left blade is inserted but is not rotated, the side of the child's head being found by placing the blade in apposition with the side of the pelvic wall. The *right* blade, on the contrary, is rotated as the head lies in the right oblique diagonal in this position, in order that it may grasp the right side of the child's head.

Describe the common varieties of obstetric forceps.

Short forceps is one in which the blades are attached directly to the handles without the intervention of a shank; it has the cephalic curve, but only a slight pelvic curve. It is used when the head is on the pelvic floor (*low operation*). *Long forceps* has a shank between the blades and the handles. It has a more pronounced pelvic curve. It is applied to the head in the cavity of the pelvis (*median operation*). The *axis-traction instrument* is a long forceps in which, by a supplementary handle attached to the under surface of the blades by rods, the tractile force is exerted in the line of the axis of the parturient canal. It may be used with advantage in the pelvic excavation in many cases, but is devised for use at the superior strait (*high operation*).

What are the dangers in the use of the forceps, and how are they avoided?

Dangers are: slipping of the instrument, septic infection, laceration of the cervix and soft tissues, and fatal compression of the fetal head.

If the instrument is properly used and undue force avoided, and if strict asepsis be carried out, all dangers may in ordinary cases be averted.

What are the unfavorable signs in delayed labor and what are the indications for the use of the forceps?

Diminution of the severity of the pains, change in fetal heart beat, rapid pulse in the mother, and dryness of the vagina.

Indications for forceps: undue prolongation of labor with above signs (other indications, see above).

What are the precautions to be employed in using the forceps?

(a) Proper indications; (b) proper introduction (especial care if introduced into the uterus, not to catch the cervix between the blades and the head); (c) careful sterilization of the instrument and cleansing of the external soft parts; (d) use of as little compression as possible; (e) avoidance of movement of rotation; and (f) prevention of slipping of the blades.

What powers may be exerted by the forceps?

The instrument is generally used only as a tractor. It may be used as a lever, a rotator, or a compressor. If used as a rotator, the danger to the child and mother is greatly increased.

Describe the procedure in a case of instrumental delivery.

The external parts must be cleansed with soap and water and a solution of bichlorid of mercury (1:2000). A vaginal douche is not given (some advise it). The woman is brought to the edge of the bed (a table is of great advantage, as it permits the position of Walcher). The short instruments may be applied with the woman upon her back or side without change of position. An anesthetic is demanded in the use of axis-traction forceps, often in operations in the pelvic cavity, and but seldom at the outlet. The application is made as described. After delivery a douche may or may not be given. The bladder and rectum must always be emptied before a forceps delivery.

Describe the method of application of the forceps at the inferior strait.

This is the '*low operation*.' The blades are applied to the side of the child's head, being rotated, if necessary. The *left* blade is introduced first in the *left* side of the pelvis and held in the *left* hand. Traction is made at intervals, if the patient is unconscious, or with the pains, if, as is usual, but little ether is given. The direction of the traction is downward and outward, and then outward and upward, until the head is about to emerge (*i. e.*, well down upon the floor of the pelvis), when the direction is made more markedly upward, the movement being then simply one of extension.

In what direction should traction be made when the fetal head is in the cavity of the pelvis?

At first downward and outward, then upward and backward.

Give the technic of the high forceps operation.

The instrument (axis-traction by preference) must be introduced through the cervix and applied to the head, generally in its antero-posterior diameter. The grip is a vicious one, as a large diameter is grasped and there is danger of slipping. Traction is made downward at first, and, as the head descends and the upper handles of the instrument rise, the traction handles must be raised so that the rods will remain approximately parallel to the upper handles. When the head has entered the pelvis, and rotation is possible, a simple forceps, applied to the sides of the head, should be substituted for the axis-traction instrument.

Compare version with the employment of forceps and state the indications for each.

Version is the shorter operation; it is indicated in conditions demanding haste, if the cervix is dilated or very easily dilatable; if the contraction ring is not 'high;' and if the head is not engaged. It may be employed in mild degrees of contracted pelvis after the forceps have been used in vain.

The most important *indication* for the employment of *version* is a shoulder presentation. It may also be employed in the treatment of face, brow, and other abnormal positions of the head. The indication for *forceps* is either a condition demanding haste, the head having engaged and the child being alive (if the child is dead, craniotomy is indicated); or an unduly prolonged labor (in the absence of an impossible presentation of the head or insurmountable obstruction to delivery).

Describe the delivery by forceps of an occipito-posterior position.

The position is generally R. O. P. The blades are applied to the sides of the head and traction is made until the head reaches the transverse position. The instruments are then removed and the case is either left to nature, the anesthetic being withdrawn, or the forceps are again applied in the same manner, but in the opposite oblique diameter, to prevent their becoming 'reversed' as the head completes its rotation.

What condition demands the use of reversed forceps?

A head extended and low in the pelvis, if it resists the various methods of manual flexion. The left blade (if held as usual) is grasped in the right hand and introduced into the right side of the pelvis, being applied to the occiput. The other blade is then applied and locked, and simple tractions are made downward until the head becomes flexed. As soon as the small fontanel is in the center of the pelvis, the blades should be removed and re-applied, if necessary, in the usual manner.

How should forceps be applied in the case of a face presentation?

In the mento-occipital diameter. They should only be used as a rotator if the chin is posterior; *i. e.*, no traction unless the chin is anterior.

COMPLICATIONS OF LABOR

Mention the varieties of hemorrhage that may affect the pregnant woman, the parturient woman, and the puerperal woman.

During pregnancy: placenta prævia and premature separation of a normally situated placenta. *During labor:* placenta prævia, premature detachment of the placenta, rupture of the uterus, lacerations along the birth canal, and rupture of a blood-vessel or of a hematoma. *After labor:* relaxation of the uterus, lacerations along the birth canal, rupture of blood-vessels or of a hematoma.

In case there is persistent hemorrhage with a well-contracted uterus, what is to be suspected and what is the proper treatment?

In all probability there is bleeding from the lower portion of the birth canal. The most usual site is the vestibule. The treatment consists, first, in the discovery of the bleeding-point by means of the gradual introduction of a tampon, and then ligature of the vessel or the introduction of one or more stitches. There may also be bleeding from the cervix, in which case, if the diagnosis has been made, sutures are to be inserted.

Name the most important forms of hemorrhage occurring during pregnancy, placenta prævia, and premature detachment of the placenta.

These occur in the latter portion of pregnancy, and to them is given the name of *antepartum* bleeding. *Intrapartum* hemorrhage is that occurring during active labor. It may be occasioned by either of the above and also by rupture of the uterus or by inversion. Severe lacerations of the birth canal may also be the cause of hemorrhage at this time. *Postpartum* bleeding is used to designate hemorrhage occurring after the delivery of the child (at any time within the first twenty-four hours) and is usually caused by relaxation of the uterus, but may also be due to rupture or inversion of the organ, or to lacerations in the lower birth canal.

What is placenta prævia? Name its causes, varieties, symptoms, dangers, and management.

An attachment of the placenta to the lower uterine segment.

The *cause* is attributed to inflammatory changes in the endometrium.

Its *varieties* are classified according to the relation which the placenta bears to the internal os uteri; they are four in number, viz.: *central*, *partial*, *marginal*, and *lateral*.

The *symptoms* are repeated hemorrhages during the latter part of pregnancy, together with difficulty in determining the presenting part on vaginal examination, and a soft, boggy vaginal vault in which pulsating vessels can be plainly felt. The external os is patulous, as is also the cervical canal up to the internal os, through which a finger can be easily pushed and the maternal portion of the placenta felt.

Treatment.—During pregnancy the gestation is to be terminated at the end of the seventh month. During labor the vagina is to be firmly tamponed to control hemorrhage and, after the os is dilated, either the extraction of the child by version or allowing the tampon to remain *in situ* until the head of the child pushes it out.

The *dangers* are fetal and maternal death from asphyxia, hemorrhage, and septic infection. A rubber bag may be advantageously substituted for the tampon.

Give the symptoms, diagnosis, prognosis, and treatment of premature separation of the normally situated placenta.

Symptoms.—Irregular cramps without resulting influence upon dilatation; an increase in the size of the uterus, with increased tension and at times a subsidiary tumor; external bleeding, which is variable in amount and may be absent entirely in rare cases; and development of symptoms of collapse. The *diagnosis* depends on the peculiar constant pain, the enlargement,

tenderness, and increased tension of the uterus, the cessation of fetal heart sounds and movements, the external discharge of blood, and the absence of a placenta prævia.

The *prognosis* depends upon the stage of dilatation and the treatment instituted.

Treatment consists in rapid dilatation of the cervix, when necessary, and delivery of the fetus by the most expeditious method.

What is inversion of the uterus, what are its causes and symptoms, and how is it recognized?

By this term is meant the turning of the uterus inside out, either in whole or in part.

Causes.—It may occur spontaneously, the uterine fundus or placental site being temporarily paralyzed, or it may result from traction on the cord before the placenta has separated. Vigorous Credé's manipulations, if performed when the organ is relaxed, may be a cause.

The *symptoms* are profound shock and some hemorrhage, with the detection of a mass in the vagina and an absence of the fundus from its usual position.

Treatment.—Removal of the placenta, if still attached to the uterus, and then immediate attempts to reduce the inversion by the introduction of the hand into the vagina and the employment of pressure upward and in a decidedly forward direction.

Give the causes, symptoms, diagnosis, and prognosis of rupture of the uterus during labor, and state how such an accident should be managed.

The *causes* of rupture of the uterus are: contracted pelvis (justominor is most usual), impossible presentations, hydrocephalus, anything which, by preventing the expulsion of the child, causes overdistention of the lower uterine segment. Neglected shoulder presentations and tumors of the lower uterine segment are also causes. As *predisposing causes* may be mentioned unduly prolonged labor, degeneration of the uterine muscle, or previous operation upon the uterus, as a myomectomy or Cesarean section.

The *site of rupture* is usually in the lower uterine segment. The *symptoms* are a sudden lancinating pain, immediate collapse, shock, signs of internal hemorrhage, recession of the presenting part, with complete or partial escape of child from uterus, the detection of the rent, and the presence of intestines in the vagina.

The *prognosis* is serious.

Treatment.—The uterus must be evacuated, and if the rupture is complete, hysterectomy is indicated or the tear must be sutured. If the peritoneal coat is found on examination not to be torn, it is permissible to watch the case for a time before resorting to an abdominal section.

What is postpartum hemorrhage? State the causes and varieties and give the treatment, including its prophylaxis.

A severe bleeding after the delivery of the child, either before or after placental delivery. It is called *primary* when it occurs immediately after

the birth of the child, and *secondary* if subsequent to the contraction of the uterus.

The *causes* are retention of placental fragments, adherent placenta, uterine inertia, and severe laceration of the lower birth tract.

The *symptoms* are hemorrhage, pallor, rapid compressible pulse, restlessness, loss of vision, and coma.

The *prophylactic treatment* consists in the use of strychnin during the latter period of pregnancy, the avoidance of exhaustion by the timely use of forceps during labor, the administration of ergot when the head is born, and the manual control of the uterus, from the time the head has been born until good contractions of the uterus have been secured after the delivery of the placenta, and the abdominal pad and binder are in place. The treatment of the active condition consists in the complete evacuation of the uterus, Credé's method of manipulation, ergot or ergotin hypodermically, intra-uterine injections of hot water, and the intra-uterine tampon. Manual compression of the uterus and aorta (Herman's method) may be tried while getting the tampon ready. Traction upon the cervix with Volsella forceps will often temporarily control the bleeding. Bleeding from the lower canal must be controlled by sutures. The *after-treatment* consists in elevation of the foot of the bed, auto-transfusion, intravenous saline injections, and hypodermic and rectal stimulation.

ECTOPIC GESTATION

Define and classify ectopic pregnancy.

The term means a pregnancy at any point outside of the uterine cavity. According to the situation the condition is classified as tubal, interstitial, tubo-ovarian, ovarian, and primary and secondary abdominal pregnancy.

What are the symptoms of rupture of an ectopic pregnancy? What is the proper treatment of the condition?

Severe, cramp-like pains in the iliac region upon the affected side and collapse, associated with the symptoms of internal hemorrhage (surface pallor, rapid, feeble pulse; air hunger, coldness of skin and extremities, vomiting, difficulties of vision, and finally coma).

The *treatment* is an immediate abdominal section.

What are the symptoms and physical signs of ectopic gestation? From what must it be differentiated? What is the etiology?

The *subjective signs* in the early months are indistinguishable from those of intra-uterine pregnancy, with the exception of the *pain*, which is characteristic in many cases, and the occurrence of *irregular hemorrhages*. The *objective signs* are an enlargement of the uterus, not, however, corresponding to the supposed period of pregnancy, and the presence of a very sensitive *tumor* at one or the other side, more rarely in front of, or very often behind, the uterus. The uterus is often displaced to the side opposite to that on which the tumor lies. There is a discharge of *decidua* in a large proportion of the cases.

The *diagnosis* depends on the history of delayed or missed menses, the

presence of the characteristic pain, the history of impregnation, the presence of the tumor, the discharge of decidua, and the early signs of pregnancy, the uterus being smaller than the period of the supposed pregnancy warrants.

This condition must be *differentiated* from an incomplete or threatened abortion. Conditions which may make the differential diagnosis impossible are: abortion in consequence of or coincident with some growth near the uterus; pyosalpinx, with an indistinct or untrustworthy history of pregnancy; intra-uterine pregnancy with the rapid development of a fibroid tumor on one side of the uterus; development of pregnancy in a uterus which is malformed.

Etiology.—Any disease of the mucous membrane of the tube depriving the cells of their cilia, forming mucous polyps, or otherwise obstructing its lumen; any condition interfering with the peristalsis of the tube.

What are the possible terminations of an ectopic pregnancy? What is the treatment of the condition before and after rupture has occurred?

Terminations.—Death and absorption of embryo (early only); rupture of the sac with profuse hemorrhage; tubal abortion (at least two-thirds of all cases end in one of these two latter); rupture of sac, with extrusion of its contents and interstitial hemorrhage into the sac wall, but without escape of blood into peritoneal cavity; tubal moles; continued growth of the fetus with death at or before maturity.

Treatment.—Immediate operation as soon as the diagnosis is made, irrespective of whether the sac has or has not ruptured.

Differentiate extra-uterine pregnancy from ovarian cyst.

Unless ovarian cyst is associated with an intra-uterine pregnancy the diagnosis is not difficult, as the uterus in the case of an ovarian cyst can be shown to be unaltered; whereas, in extra-uterine gestation there are changes in the size and consistence of the uterus. If the cyst is small and limited to the pelvis, and if there is a threatened abortion present, the diagnosis may be of great difficulty. The chief points are the presence of characteristic pain in the case of extra-uterine pregnancy, both by history and on palpation of the tumor, and its relative absence in ovarian cysts.

THE PUERPERAL STATE

What is the puerperal state?

The puerperium is the period following the delivery of the placenta. During this period, which may be said to continue for six weeks, the uterus, vagina, etc., are undergoing involution; *i. e.*, are returning to their normal unimpregnated condition. The pelvic blood supply becomes markedly lessened.

What are the most frequent complications of the puerperal period?

Infection, either local in some portion of the birth canal, or general, through the blood or lymph tracts; subinvolution of the uterus; inflammation or abscess of the mammary gland; postpartum hemorrhage.

What care does the mother require after labor?

Aseptic cleansing; occlusive dressings to the vulva; application of the abdominal binder and pad; changed bed-linen; an additional dose of ergot and 'holding' the uterus until it contracts firmly; tendency to counteract the uterine relaxation. The head should be kept low, and visitors, except the mother and husband, must be excluded. At the subsequent visits the pulse, temperature, bowels, vaginal discharge, and the condition of the breasts must be inquired into. Involution must be carefully watched. A liquid diet is preferable until the bowels have freely moved.

What changes occur in the uterus subsequent to delivery?

Fatty degeneration, absorption, and obliteration of blood-vessels. By these means the uterus gradually returns to a condition approximating that before impregnation.

How should a puerperal patient be catheterized?

Catheter and hands of operator should be surgically clean. Meatus and vulva exposed and cleansed with bichlorid solution. Catheterization every eight hours is sufficient. The danger of infective cystitis is particularly great at this time.

What is the lochia? What are its normal characteristics and how may they be altered by diseased conditions?

The *lochia* is the discharge from the uterus which follows delivery and continues for about fourteen days. It is composed of blood, degenerated epithelium, mucus, and micro-organisms. For the first five days it is almost entirely composed of blood; it then becomes serous, owing to catarrh of the mucous membranes; and later presents the characteristics of healthy pus, being composed at this period of micro-organisms, degenerated epithelium, and pus from the granulating wounds of the tract. The normal *odor* is at first that of raw meat.

Delay in involution and malpositions of the uterus may cause a continuance of the bloody lochia and retention of blood clots with saprophytic invasion, which gives rise to a fetid odor. Complete suppression may occur. An entire absence of odor is compatible with the existence of most grave infection.

Give the technic of puerperal antisepsis.

All instruments, bed-linen, water, dressings, etc., must be surgically clean. The hands of the doctor must be surgically clean (washed in soap and water with a nail-brush for ten minutes, then in bichlorid for two minutes), and it is well to wear rubber gloves. No one in attendance upon the case should have been in attendance upon a case of contagious disease or septic condition. As few vaginal examinations are to be made as possible. No vaginal douches are to be given unless there are special indications.

Give the causes and the treatment of after-pains.

They are caused by painful contractions of the uterine muscle and are most marked in multiparæ, since in primiparæ the muscle of the uterus is stronger and approaches, as it were, a condition of tonic spasm. Their purpose is to evacuate the uterus and to aid involution. The treatment is ergot and opium (either morphin or paregoric).

What is involution and how long a time is required for its completion?

Involution is the term applied to the reduction, after labor, of the uterus, its ligaments, the ovaries, and the vaginal tract to the normal non-pregnant condition. About *six weeks is the time usually required.*

When and how is a repair of a lacerated cervix to be performed? Of a lacerated perineum?

Immediate repair of a lacerated cervix is indicated in severe hemorrhage alone. By some authorities the advice is given to repair lacerations of the cervix on the sixth day after labor, as a routine method of treatment, but the majority teach that better results are obtained by the 'late operation.'

The perineum should, in the opinion of the majority of operators, be restored as soon after labor as possible. Some hold that it is better to wait a week in order to allow the edema to subside and to gain good surgical surroundings.

The repair of both of these structures depends upon the accurate apposition of the wound areas. Great care must be exercised to carry the sutures to the bottom of the lacerated area. Either silkworm or catgut may be used as suture material.

What is galactorrhea? Give its treatment.

A flow of milk from the breasts not necessarily excited by the suckling child and usually continued long after the usual term of lactation. Usually both breasts are involved. The duration may extend over years.

The *treatment* is often not satisfactory. The cause is unknown. A condition of general debility known as tabes lactea may result. The breast-pump must be used to remove excess of milk, together with regular feeding of the infant. Ergot in small repeated doses, potassium iodid in moderate doses three times a day, and belladonna ointment may be used. Firm compression of breasts by a binder is essential.

At the final examination after labor what structures and organs are to be investigated?

This examination is made four weeks after delivery. It includes an inspection of the external perineum, an examination of the integrity of the levator ani-muscle, an inspection of the cervix, a bimanual examination of the uterus to determine its size, position, and mobility, together with the condition of the ovaries as to size and mobility. The coccyx should be tested for the presence of pain or mobility, and the presence of a movable kidney should not be overlooked. Diastasis of the recti muscles is also to be looked for.

Give a clinical description of puerperal insanity. State the causes and management of this condition.

About 8 per cent. of all insanity in women has its origin in child-bearing. Mania, melancholia, and dementia are the varieties met with in the order of frequency. Time of occurrence is *first* the puerperium; *next*, during lactation; and *last*, in pregnancy. Homicidal and suicidal tendency is common. The condition must be distinguished from a temporary delirium

of labor; (b) delirium tremens (labor, as any other severe strain may be the cause of an attack in a hard drinker); (c) delirium of fever, due to infection (it may be necessary to await the disappearance of the fever before making a diagnosis); (d) pre-existing insanity.

Treatment is best carried out in an asylum. It consists in the administration of a modified rest cure, with tonics and forced feeding.

Define puerperal mania. Give its etiology, symptomatology, and treatment.

It is the usual form of puerperal insanity. Its *etiology* is often impossible of determination, but heredity, anxiety, difficult labor, and septic infection are predisposing causes. Its onset is often abrupt and its *symptoms* are those of wild delirium, hallucinations, and suicidal and homicidal tendencies. The largest proportion of cases recover, while the remainder, about one-third, die or remain permanently insane.

Treatment as in preceding question.

How soon after parturition should a woman menstruate?

If she nurses her baby, her menses usually do not return until about the ninth month. At any time after the second month, in women whose children are not at the breast, there may be a return of the menstrual flow. Early return under normal conditions of nursing should direct attention to a possible subinvolution.

Define puerperal sepsis and state its prophylaxis. What is auto-infection?

Puerperal sepsis is the infection of the puerperal woman with pathogenic germs. Its *prophylaxis* consists in the observance of the principles of asepsis and antisepsis during the delivery and in the puerperium.

Auto-infection is the rarest form of septic infection. The germs are already resident in the woman's system before her delivery and are rendered active by the influence of labor.

Mention the pathogenic organisms that may be found in the vagina and state how the vagina combats them.

Streptococcus pyogenes, Staphylococcus pyogenes aureus and albus, Bacterium coli commune, Bacillus pyocyaneus, Bacillus fœtidus, etc. In the vagina there are normally present a great number of long, rod-shaped bacilli (Döderlein's) whose function is protection against invasion by the production of an acid secretion.

Give the differential diagnosis of puerperal sepsis.

Any case which shows fever after delivery is to be considered as septic until proven otherwise. Intercurrent conditions are met with, however, as typhoid fever, pneumonia, tuberculosis, malaria, influenza, etc. The diagnosis in the absence of distinct localized lesions may be very difficult unless blood-examinations are made. By the latter the presence of the malarial parasite, the bacillus of typhoid fever, or the various organisms capable of producing sepsis may be detected. Intra-uterine cultures may

also be of use in obscure cases. In the usual case the only differential diagnosis necessary is between malaria, typhoid fever, and septic infection. This may usually be easily made by the blood examination. The history of the case previous to delivery is of importance.

Give the etiology, prognosis, and symptoms of puerperal fever.

(a) Direct infection, by the introduction of germs from without; (b) the invasion of the uterine cavity by micro-organisms which cause putrefactive processes in the presence of retained deciduæ; (c) so-called auto-infection, the pathogenic organisms having been resident in the body before the occurrence of the labor.

In the cases of sapremic absorption the *prognosis* is good if the proper treatment, evacuation of the uterus, is instituted early. In neglected cases these infections may become very grave. In cases of true general sepsis in which there is a blood infection by the organisms themselves, the prognosis is always grave. In the cases in which a local abscess is formed, the prognosis is that of the surgical condition presented.

The *symptoms* are fever, chills, rapid pulse, nausea, and vomiting; often some pain and tenderness in the abdomen, with rigidity and tympany. There may be foulness of the lochia, but in the most severe cases of general blood infection the discharge may be absolutely non-offensive.

What are the varieties of puerperal sepsis?

Sapremia, or putrid absorption, the symptoms being due to the absorption of toxins derived from retained decomposing products in the uterine cavity. In these types no focus of infection is to be found outside of the uterus and, while the cultures from the endometrium may show a growth of pathogenic micro-organisms, the blood-cultures are negative; peritonitic forms (either local or general); septicemic (blood contains organisms).

What different lesions may be caused by puerperal sepsis?

Inflammation of the lining membrane of the lower birth canal (colpitis, endocervicitis, endometritis); false membrane formation upon wounds of the lower tract; metritis, perimetritis (a cellulitis of the para-uterine tissues); salpingitis and ovarian abscess; peritonitis, either local or general; metastatic abscesses; blood infection; phlebitis (uterine and para-uterine, with or without phlegmasia alba dolens); cystitis, ureteritis, and pyelitis.

What is the treatment of puerperal sepsis?

Evacuation of the uterus by finger, placental forceps, and curet. Intra-uterine douches; alcohol in liberal amounts; strychnin, digitalis, etc.; forced feeding; antistreptococcic serum (effect questionable); saline solution by intravenous injection, by injection under the breast, or into the bowel; Nuclein to increase phagocytosis; evacuation of any focus of suppuration that may be discovered; rarely, extirpation of the uterus for suppurative metritis.

Local infections in the lower genital tract, most often occurring in wounds, indicate the application of antiseptic agents, as silver nitrate.

By what measures may puerperal sepsis be avoided?

By the most careful observance of all the precautions of asepsis and by the employment of antiseptic measures whenever needful. Among the most important special measures may be mentioned the avoidance of frequent vaginal examinations, and the careful cleansing of the outlet before attempting any examination or operative procedure. It is also of the greatest importance to interfere at the proper period of labor, thus avoiding the predisposition to sepsis occasioned by a prolonged parturition with the consequent devitalization of tissue.

How is puerperal metritis to be diagnosed and what methods are to be employed in its treatment?

The *diagnosis* is very difficult. There is a condition of subinvolution of the uterus, with bogginess and sensitiveness on pressure. The only certain sign is the discovery of a mass in the wall of the organ or the rupture of an abscess into the uterine cavity.

The *treatment* of the condition is hysterectomy, but the operation has but a very slight field, as the diagnosis can seldom be made in time.

How is phlebitis to be guarded against?

By the avoidance of all unnecessary interference during the course of labor; by the prompt intervention in suitable cases, to prevent undue prolongation of labor; by a strict observance of all points in asepsis and antisepsis; by insistence upon a sufficient sojourn in bed after delivery. The condition occurs at times as a sequel to a normal, easy labor.

State the causes, symptoms, pathology, treatment, and sequelæ of puerperal phlebitis.

Causes.—The veins of the uterus and pelvic connective tissue are prone to thrombosis because of the sluggish circulation, the pressure of pregnant uterus, and the alteration of the blood in a puerpera.

Pathology.—The clots may be infected at the placental site and swept into the circulation, producing *pyemia.* On the other hand, the veins may be infected in their walls by passing through a septic region. This is followed by a clotting of blood and either a limitation of the process or an infection of the clot with resulting pyemia, as above. Serious bleeding may occur from a perforation of the vessel wall. This form of sepsis is least likely to cause peritonitis, but is most likely to result in pyemia. Embolic septic processes are often observed. Phlegmasia alba dolens is a very common accompaniment.

The *symptoms* are high, irregular, and long-continued fever; great depression; a very rapid pulse; and a complete absence of all local symptoms of septic infection. In the course of the disease the symptoms of pyemia may develop and '*milk-leg*' will almost certainly occur, either as the first symptom or during the course of the disease.

Treatment consists in disinfection of the uterine cavity; rest and stimulation. The patient is to be kept in bed for at least ten days after the temperature has become normal. As a rule, the condition ends in recovery.

What is phlegmasia alba dolens? Give the varieties, symptoms, and treatment.

A condition of thrombus formation in the veins of the lower extremity or pelvis which interferes with the circulation and leads to marked edema, with a tense, glistening, and milk-white skin ("milk-leg"); or a septic inflammation of the connective tissue of the pelvis and thigh, the infection spreading from the perineum or from the deeper pelvic fascia through some of the foramina.

Instances of the former (*thrombotic variety*) are much more common than of the latter (*cellulitic variety*). The first form is to be divided into two classes, viz.: those in which the thrombosis is *primary*, being an extension of the process from the uterine sinuses and due to stagnation of the blood current and to the pressure to which the vessels are subjected during pregnancy. In the other there is a *septic infection* of the blood-vessel wall, leading to a *secondary* thrombosis. In the first variety there are few symptoms and little fever, while in the latter the systemic symptoms are grave and the fever is high. The first variety may pass into the other by an infection of the blood-clot.

Symptoms.—A heaviness and stiffness of the leg develops between the tenth and the thirtieth days, associated with pain in the calf of the leg and edema ascending from the foot in the thrombotic form, or descending from the groin if the condition is due to septic inflammation of the connective-tissue. In the former variety there is likely to be a red line, with tenderness along the course of the femoral vein. The general symptoms are fever; gastric and intestinal disturbance; profound depression and restlessness. The condition is a very common accompaniment of a phlebitis of the pelvic tissues.

The most usual *cause* is a septic inflammation of the blood-vessel walls, beginning at the placental site and extending through the pampiniform or utero-vaginal plexuses downward to the femoral vein, or upward through the spermatic vessels to the vena cava.

The *prognosis* is doubtful; pyemia, local abscess formation, and gangrene may occur. In rare case there may be a development of elephantiasis from the long continuance of congestion. Pulmonary embolism is a most dangerous complication. The favorable terminations are absorption of the clot with restoration of the circulation, or its organization with occlusion of the vessel and establishment of a collateral circulation.

The *treatment* is absolute rest in bed; elevation of the limb; bandaging the limb in cotton; free stimulation. The patient is not allowed to get up until ten days after the disappearance of all symptoms. If the limb is weakened by the lack of use, massage may be employed after all local symptoms have disappeared. If any abscesses develop they must be opened. In rare cases the interference with the circulation is so marked that gangrene develops and amputation is demanded.

Give the varieties, pathology, symptoms, and treatment of puerperal mastitis.

The condition may or may not result in suppuration. Its *causes* are microbic infection, which occurs either from without, due to a faulty asepsis of the nipple, or more rarely, from the presence of organisms within the

lactiferous ducts (Staphylococcus albus); these latter may be considered as a normal content, but under the influence of engorgement, etc., they are at times able to cause a suppurative mastitis.

The *pathology* of the condition may be an inflammation of the subcutaneous connective tissue of the gland, of its deeper interstitial tissue, or of the parenchyma.

The *symptoms* are acute pain, malaise, elevation of temperature, headache, and, in severe cases, induration. If the induration is at all marked, an abscess is probable.

Treatment.—Hot compresses of lead-water and laudanum, ice-bags, mammary binder, ichthyol or belladonna locally, and free purgation. The child should not nurse. The breast-pump is to be used and massage may be applied with great gentleness.

Give the symptoms and treatment of mammary abscess.

The condition is most common in the third or fourth week of the puerperium, but may occur at a later period, or during pregnancy.

The *symptoms* are pain of a dull, throbbing character, with chills and fever of a hectic type. The indurated portion of the breast becomes, as a rule, somewhat soft or doughy, and fluctuation is noted in some cases. There is often some duskiness of the skin and there may be edema with lividity and glazing of the skin. It is to be remembered that the local symptoms are obscure in a certain number of cases, and an incision is to be made upon the probability of there being pus present without waiting for all the classical symptoms to present themselves. Rarely, the pus forms behind the gland in the areolar tissue just above the pectoral muscle (*retro-* or *submammary abscess*). In the latter condition there is a tendency to burrowing, and the breast is raised off the chest wall and becomes very prominent. There may be no distinct local symptoms.

The *treatment* is early incision, the line radiating from the nipple; the wound is to be dressed antiseptically, either gauze or rubber tubes being used to secure good drainage. If the condition is neglected it usually becomes necessary to make multiple incisions.

CARE OF THE INFANT

Describe the care of the infant during the first twenty-four hours after birth.

After the establishment of respiration and the severing of the cord the baby should be given a bath. The vernix caseosa must be removed by rubbing with sweet oil. Castile soap and warm water are to be used in cleansing, and care must be taken to protect the skin against irritation. Diapers must be changed every hour, and plenty of talcum powder must be dusted on the body, especially in its folds, to prevent chafing. Give the breast to the baby every four hours. In this way it soons learns to nurse at regular intervals. The fluid which it receives during the first forty-eight hours is not true milk, but is known as *colostrum*, and serves to empty the child's bowels, thus getting rid of the meconium. If the bowels do not become light in color in a few days, it is well to give a dose of castor oil, which will result in relieving the bowel of meconium. Early nursing is advantageous, as it reflexly causes firm uterine contractions.

State the conditions indicating artificial feeding, and describe the proper method of modifying cows' milk for the newly born.

Inability on the part of the mother to nurse her child, either because of lack of milk, or, more rarely, because her milk proves unsuitable; maternal tuberculosis; and grave blood diseases in the mother.

Method of Modifying Milk.—(a) Determine the proper amount to be given: during the first week 10 oz. in the twenty-four hours, at two-hour intervals. (b) Dilute to reduce the casein, add cream and milk-sugar, rendering the mixture alkaline. (c) Pasteurize.

What hygienic precautions are necessary for a nursing child if the mother has sore nipples?

An artificial nipple or, if the breast is too painful, artificial feeding. The breast must receive appropriate treatment.

Upon which side is the new-born infant to be placed?

Upon its right side, as it is supposed that the closure of the foramen ovale is favored by this position and that the flow of blood from the ascending cava, over the Eustachian valve into the right auricle, is facilitated.

Describe the proper measures for the care of the new-born child.

Resuscitate; cleanse eyes and mouth; cut cord when pulsations have ceased; anoint with oil and bathe; dress cord; put to the breast in four hours; dress in an abdominal binder, knit shirt, diaper, knit shoes, two skirts, and a dress.

Give the proper care of premature infants.

Low temperature and inability to ingest and digest food are the deviations from the normal. Treat by incubation and gavage or by feeding with the medicine-dropper. Do not bathe, but instead give inunctions of warm oil. Wrap in wool instead of clothing.

What is premature respiration?

The establishment of the function before the birth of the head. Its occurrence is due to some cause interfering with the placental functions. It may occur also during the performance of version, due to irritation of the skin of the child. The danger is that some of the maternal discharges or other fluids may be inspired, with the resulting development of a fatal pneumonia.

What indications of premature birth can be determined by the appearance of the infant?

Redness of color with small amount of vernix caseosa; dearth of subcutaneous fat, the skin hanging in folds; weak cry, limp muscles, shallow breathing; sucking and swallowing are performed with difficulty; eyes are closed; lanugo uniformly covers skin; sutures and fontanels are wide; nails are soft and do not extend to the finger ends; and temperature tends to be subnormal.

What condition results from imperfect closure of the foramen ovale?

Arterial and venous blood are both forced into the aorta. The term "blue baby" is used to describe the resulting condition of general cyanosis. The condition is not necessarily fatal.

What are the causes of still-birth?

Various intra-uterine diseases, asphyxia from pressure on the cord or interference with placental circulation, as in eclampsia or premature separation of the placenta. Trauma dependent upon some obstetric operation may also be a cause. A true knot of the cord, pulled tight during a version, has been noted as a cause of still-birth. It is to be remembered that "still-born" is not to be used with reference to asphyxia, but is only to be applied to those children actually dead at birth.

Describe the methods for the resuscitation of a still-born child.

See that the throat is clear of mucus before adopting one of the following: (a) Slapping the buttocks, hot and cold douching, or electricity. (b) Sylvester's method, not to be recommended. (c) Hall's method—suspending infant in a towel and rolling it from side to side. (d) Byrd's method—flexing and extending the trunk and holding the child upside-down. (e) Schultze's method—wrap in towel, grasp shoulders with the thumb and index fingers, the other fingers being extended along the back of the child, which is turned toward the operator. Swing between knees and over shoulders slowly, frequently immersing in warm water. (f) Mouth-to-mouth insufflation through gauze (the nose is not to be closed). (g) Tracheotomy and catheterization through the wound (very rarely required). The best of these methods are Schultze's and mouth-to-mouth insufflation.

How would you decide that a dead infant had been born alive?

By the presence of air in its lungs.

Give the signs of fetal death in utero and the proper treatment of the mother when this condition occurs.

Cessation of fetal movements and heart sounds. Cessation of abdominal growth; appearance of the milk secretion; retrogressive breast changes; palpation of a macerated skull; and peptonuria.

The *treatment* is evacuation of the uterus upon a positive diagnosis.

Give the causes and treatment of colic in infants.

The *cause* is often some maternal dietary indiscretion, too rapid or prolonged nursing, or the presence of some deleterious substance in the milk.

Treatment.—Correct the cause, if possible, and give pepsin, 1 gr., in hot water. Brandy or gin in doses of a few drops may be added. Milk of asafetida, 20 to 40 drops, or soda mint in dram doses may be given internally, or a spice poultice may be applied.

Define and give the treatment and prophylaxis of ophthalmia neonatorum.

The term is usually limited to a *gonorrheal conjunctivitis*. From twenty-four to forty-eight hours after labor edema of the eyelids occurs. Redness of the conjunctivæ and a profuse purulent discharge containing gonococci are soon noted. Later, desquamation of the corneal epithelium, glazing, ulceration, and perforation of the cornea may occur.

The *prophylaxis* consists in careful cleansing of the eyes after birth and the instillation of either nitrate of silver (one drop of a 1-per cent. solution) or a few drops of a 5-per cent. protargol solution, or a 2-per cent. solution of argyrol.

The *curative treatment* consists in careful hourly cleansing of the eyes with a concentrated solution of boric acid; cold compresses; instillation of nitrate of silver (1 drop to a 20-gr. solution), with subsequent irrigation with salt solution. Protargol or argyrol may be used in appropriate strengths. Weak solutions of atropin are required at times. An oculist should be consulted, if possible.

What is meconium and what is its diagnostic importance?

Meconium is the name given to the contents of the fetal bowel. It is composed of mucus, bile, vernix caseosa, epithelium, hair, fat crystals, and bacteria. It is greenish-black in color.

When it appears during a birth it is a danger sign if the presentation is a vertex, but if a breech, there is no significance to be attached to its presence.

Name the diseases of the fetus and its membranes in utero?

Tuberculosis (rare); rickets (common); syphilis (common); new growths (rare); malformations (general anasarca, congenital cystic elephantiasis, amputations, luxations, fractures); infectious diseases, as cholera, small-pox, etc. (rare); meningocele, hydrocephalus. The diseases of the *membranes* are hydramnios, oligohydramnios, and cystic disease of the chorion.

What is hydatidiform mole? What is its treatment?

A cystic change, the result of myxomatous degeneration of the ends of the chorionic villi.

The *symptoms* are: (a) very rapid enlargement of the uterus; (b) hemorrhage; (c) cystic or doughy feel on palpation, with lack of distinct fetal parts and absence of heart-sounds. The only absolute sign is the discharge of cysts.

Sequelæ: death of the fetus; septic peritonitis; and malignant change in the uterine wall (deciduoma malignum).

Treatment.—Termination of pregnancy as soon as the diagnosis is made. The uterus may be evacuated after dilatation of the cervix by the curet, fingers, and placental forceps; but great care must be taken to avoid perforation, as the tendency of the growth to invade the muscle tissue makes this accident likely.

How does constitutional syphilis in the parents affect the infant, and how can its presence be detected in the latter?

Manifestations are bullous eruptions of the skin, condylomata, inflammations of the mucous and serous membranes, gummatous and miliary

deposits, morbid growth of connective tissue in the brain, lungs, pancreas, kidneys, liver, spleen, the muscular system, the intestinal walls, the blood-vessel walls, osteitis, and osteochondritis. Three diagnostic points of great value are: (1) yellow line between diaphysis and epiphysis; (2) a marked increase in the weight of the liver, and (3) increased weight of the spleen.

What diseases of the mother are liable to injure the fetus in utero?

Syphilis, tuberculosis, the exanthemata, renal inadequacy, eclampsia; any disease affecting the circulation, as chronic heart, liver, and lung diseases. Spasmodic maternal affections, as chorea, may also do damage.

What are the causes and symptoms of asphyxia in the new-born child?

1. *Intra-uterine Causes.*—Fetal inspiration; any interference with placental respiration, as coiling or prolapse of the cord; diminution in the caliber of the placental vessels, as from syphilitic periphlebitis; excessive uterine contractions; prolonged pressure on the fetal brain by forceps or by the pelvis; grave systemic disease of the mother; and accidents, as uterine or pulmonary hemorrhage.

2. *Extra-uterine Causes.*—Placing infant in an unfavorable position for respiration; precipitate labor; interference with access of air to lungs, as by a caul or maternal discharges.

The condition occurs in two varieties: (a) *asphyxia livida*, in which the color is cyanotic from excess of CO_2, but the circulation continues and the reflexes are preserved. The prognosis is favorable. (b) The second variety is known as *asphyxia pallida;* the reflexes are abolished, the heart action is very weak, and the prognosis is unfavorable.

Give the causes and treatment of umbilical hemorrhage in the new-born child?

It may be *primary* from careless ligation of the cord; or *secondary* after the cord drops off. The vessels of the cord close from the placental end inward and the hypogastric arteries may be patulous after the cord falls. At any time before the ulcer is healed there may be a bleeding noted, as a symptom of grave infection.

The *treatment* consists in religating, in catching the bleeding points, by medicated pressure as by the use of Monsell's solution on compresses or, finally, by the use of a ligature and hare-lip pins. When it is a symptom of infection, the condition is, as a rule, fatal.

Give the pathology of hydrocephalus. State how the condition may be recognized before delivery and the proper treatment of the complication.

Hydrocephalus is an excessive collection of cerebro-spinal fluid within the ventricles of the brain.

Pathology.—Enlargement of the skull with delay in the closure of the fontanels and sutures. The bones are very thin, the skull is entirely out of proportion to the face in size, and the forehead bulging.

The condition is to be suspected when, no other cause being ascertainable, the head refuses to engage in a pelvis of normal size. The *diagnosis* depends upon the recognition of the enlarged head, the wide sutures and fontanels, fluctuation, and abnormal tenuity and mobility of the bones.

The *treatment* is craniotomy.

Give the possible traumatic effects of labor upon the child.

Meningeal hemorrhage; crushing of the substance of the brain; less severe injuries to the brain, resulting in lack of development; compression of the brain. Peripheral paralysis, most usually of the facial and brachial plexuses. Spoon-shaped depression of the parietal and frontal bones; fractures of the bones of the skull or extremities; distortion of the head (common); caput succedaneum (common); cephalhematoma, due to a subpericranial hemorrhage (may be fatal). Slough of the scalp from pressure within the pelvis; torticollis due to injury of the neck muscles; dislocations.

GYNECOLOGY

Describe the female reproductive organs.

The *ovaries* are placed laterally to the uterus, being attached to the posterior layer of the broad ligaments. They are 3.5 cm. in length, 2 cm. in width, and 1.5 cm. in thickness. They are glandular in structure and of an almond shape. The gland spaces have no ducts, but discharge their contents by rupture of their walls. The organ is divided into *cortex* and *medulla*, the former containing the ova.

The *Fallopian tubes* are the oviducts. Two in number, each about 10 cm. long, they pass out from the uterine cornua in the upper edge of the broad ligaments. Their distal ends, or fimbriæ, are in relation with the ovaries. They are lined with ciliated epithelium, which helps to transport the ova to the uterus. The tubes have three coats: serous, muscular, and mucous.

The *vagina* is the passage from the vestibule to the cervix. It lies at an angle of 60° with the horizon. The *hymen* is the fold of vaginal membrane at the introitus vaginæ. It is usually ruptured at the first coitus.

The *external genitals* include the *labia majora*, *labia minora*, *clitoris*, *vestibule*, and *mons veneris*. The labia are the fleshy folds on each side of the vaginal entrance. The labia minora or nymphæ are within the greater lips and unite to form the prepuce of the clitoris. The vestibule is the triangular space bounded by the clitoris, the labia minora, and the entrance of the vagina. The mons veneris is the fleshy eminence above the symphysis pubis.

The *uterus* is the muscular organ situated in the cavity of the true pelvis, and contains the fetus until it is delivered. It is composed of three layers of muscles and is divided into the *body*, or corpus, and the *cervix*. The cervix is inserted into the upper wall of the vagina, into the cavity of which it projects. The uterus is maintained in its position by the *broad*, *round*, and *sacral*, *ligaments*, and by the intra-abdominal pressure. It is lined with mucous membrane, which forms the resting-place of the ovum during its development.

Describe the human uterus and give its anatomic relations.

The uterus is a hollow, muscular organ, situated in the center of the pelvis and embraced by the folds of the broad ligaments. It is in relation with the bladder anteriorly, and is separated posteriorly from the rectum by the cul-de-sac of Douglas. The upper portion, above the point of entrance of the Fallopian tubes, is called the *fundus;* the portion between the tubes and the internal os, the *body* proper. The *cervix* extends from the *internal os* above, to the *external os* below.

Give the size, weight, measurements, and location of a normal virgin uterus.

Three inches in length, 1½ to 2 in. in breadth, and about 1 in. in thickness. It weighs from 7 to 8 drams. It is situated in the pelvis, between the bladder and the rectum.

Give the blood and nerve supply of the uterus, ovaries, and vagina.

The *uterine artery*, a branch of the *hypogastric*, gives off a branch to the *cervix* and passes upward along the uterus to anastomose with the *ovarian artery*, a branch of the aorta. The *veins* form a free plexus around the uterine artery, unite to form the *uterine vein* on each side, then empty into the *hypogastric vein*, and finally into the *internal iliac*. The blood from the ovary and the upper part of the broad ligament is collected by a number of veins which form the *pampiniform plexus*, the vessels of which terminate in the *ovarian vein.*

The blood supply of the *vagina* is derived from the uterine artery and from the *vaginal arteries*, branches of the anterior trunk of the *internal iliac.*

The *nerve supply* of the *uterus* is derived from the inferior hypogastric, the renal plexuses of the sympathetic, and the third and fourth sacral nerves. The *ovaries* are supplied by the ovarian plexus of the sympathetic, and the *vagina* derives its nerve supply from the hypogastric plexus, the fourth sacral, and the pudic nerves.

Describe the physiology of ovulation and menstruation.

1. Development of the ovule within the Graafian follicle. 2. Increase of intrafollicular tension, due primarily to increase of the blood supply. 3. Rupture of follicle, with discharge of contents, consisting of the ovum, the liquor folliculi, and a few cells of the discus proligerus (Menstruation, see page 539).

Ovulation and menstruation are not necessarily synchronous. Whether the discharge of the ovule occurs before or after the menstrual flow is not settled. Its causation is a nervous stimulation proceeding from the sympathetic ganglia in the lower abdomen and pelvis, causing a congestion of the sexual organs. It consists in a diapedesis of blood through delicate, newly-formed capillaries of the thickened and congested endometrium.

What is the mechanism of the escape of the ovule and its transmission to the tubes and uterus?

When puberty is established there is a discharge of the ovule, due to its approach to the surface of the ovary and to the increase in the intra-

follicular pressure. It is then carried to the Fallopian tube by the current of moisture which exists upon the surface of the peritoneum. After its entrance into the tube the ovule is carried down toward the uterus by the action of the cilia.

Give a description of the physiology of menstruation.

Menstruation is the periodic discharge of blood from the uterus, and possibly from the tubes, of the non-pregnant woman, from puberty to the menopause. It may occur every twenty-eight days, or every two, three, or five weeks. The discharge consists of blood, mucous secretion from the uterus and vagina, and epithelial cells from the endometrium.

Describe the phenomena of menstruation.

Weight and heaviness in the pelvis; nervous excitation; painful uterine contractions; swelling of breasts; pain in breasts; enlargement of the thyroid gland; swelling of tonsils and vocal cords; increased vascular tension; increased heart activity; slight elevation of temperature; slight increase in the vascularity and pigmentation of the skin; increased activity of the sweat and sebaceous glands; and the *characteristic discharge.*

v. Ott demonstrated the fact of a regularly recurring wave in all the physiologic processes. The greatest activity is manifested just before the appearance of the flow.

What is the duration of menstruation, and what are the resulting changes in the uterine mucous membrane?

From three to seven days.

Marked swelling of the mucous membrane; increase in the size of the glands. Rupture of blood-vessels occurs only to a slight degree, if at all, the main cause for the menstrual flow being a diapedesis due to the fact that the provision for carrying blood to the membrane is more ample than that for its removal. At the completion of the period there is a shrinking of the endometrium, and the extravasated blood in the intercellular tissues is absorbed; while the surface epithelium, lifted away from its attachments by the interstitial hemorrhage, again sinks to its normal level and becomes adherent.

What are the abnormalities of menstruation? Give their etiology and treatment.

Amenorrhea, absence of the flow; *scanty* or *insufficient* flow; *precocious* or too early appearance; *acute suppression* (during a period); *vicarious*, flow of blood or other liquid from other organs instead of from the uterus; *menorrhagia*, excessive bleeding at the period; *metrorrhagia*, flowing between the periods; *dysmenorrhea*, or difficult and painful menstruation.

Acute suppression may result from exposure to cold or emotional excitement at the time of the flow. There may be no symptoms other than the cessation of bleeding, but ovarian and pelvic pain may be complained of.

The *treatment* consists in rest in bed, warm fomentations to the lower abdomen, and hot foot-baths. The treatment of the other abnormalities is discussed elsewhere (see page 540).

What is vicarious menstruation?

A periodic discharge of blood or other fluid from the nose, breast, stomach, or other organ, the usual uterine flow being absent.

What changes take place in the female at puberty?

Menstruation appears; ovulation is established; the breasts develop; hair appears above the pubis; the sexual feeling develops; the pelvis widens.

What conditions have a bearing on the time of life when menstruation first occurs?

Race, social condition, climate, and predisposition. The average age in temperate climates is about fourteen years.

What are the most useful emmenagogues?

Potassium permanganate (1 to 2 gr., three times a day); dioxid of manganese in the same dosage. As a rule, they are of little value.

Define menorrhagia and dysmenorrhea, and give treatment of each.

Menorrhagia is an excessive flow of blood at the menstrual period. It may be a sign of carcinoma, of endometritis, or of some obstructive disease of the circulatory system. Its treatment is the treatment of the cause.

Dysmenorrhea is painful or difficult menstruation (for treatment, see next question).

State some of the causes of dysmenorrhea. Give the treatment.

Some obstruction to the escape of menstrual blood; hyperesthesia of the endometrium; lack of development of the uterine blood-vessels (caliber insufficient to contain the blood, which is in excess at the period); lack of development of the uterus itself; disturbance of the general nervous system; ovarian or tubal disease.

Treatment.—Hygienic; dilatation and curetment; abdominal section, when due to ovarian or tubal disease.

What are the symptoms and treatment of amenorrhea?

Amenorrhea is a total suppression of the menstrual flow. It is generally associated with anemic conditions and may be accompanied by leukorrhea, headache, flashes of heat, nervousness, nausea and vomiting, and pelvic pains. It may also be a symptom of lack of development of the pelvic organs.

Treatment is to be directed to improving the general condition by means of tonics, nourishing food, etc. Some good may be obtained by the use of emmenagogues in selected cases. Dilatation of the cervix is of value at times. Pelvic massage and electricity may be tried.

Mention some of the principal causes of sterility operative in women and state how fertility may be promoted.

Stenosis of the cervical canal from anteflexion; retrodisplacement of the uterus; cervical catarrh with profuse leukorrhea; chronic salpingitis; chronic endometritis.

Treatment.—Correction of any of these conditions that may be found.

What is the menopause and how is the popular theory that it is a critical period in a woman's life to be explained?

The menopause is the cessation of the phenomena of menstruation and usually supervenes about the forty-fifth year. It may occur decidedly earlier, or not until several years later. Ovulation ceases at this time and the ovarian influence is thereafter wanting. In many instances there are no untoward symptoms; but a considerable number of women suffer more or less from nervous manifestations.

The most important pathologic condition that may develop at this time is carcinoma of the uterus. Obesity is also rather frequently encountered, and insanity may occur.

What are the causes of hemorrhage from the non-pregnant uterus? Give the treatment for the most usual forms.

Carcinoma; intramural fibroids; endometritis; polyps; uterine tuberculosis; inflammation and neoplasms of the tubes and ovaries; chronic metritis; certain constitutional diseases.

Treatment.—Carcinoma and uterine tuberculosis, if seen early, demand hysterectomy; fibroids, either hysterectomy or myomectomy. Endometritis should be treated by curetment, and intra-uterine polyps removed through the dilated cervical canal.

Give in detail the method to be used in making an examination of the pelvis.

The bladder and rectum having been emptied, and all constricting clothing loosened, the patient is placed in the dorso-sacral position. The vulva is cleansed, and the examiner introduces the index finger (usually of the left hand) into the vagina, the other hand being placed upon the abdomen just above the pubis. After locating the cerxiv and the fundus uteri, the examiner passes the hand outward, allowing the tissues to pass between the fingers.

What are the symptoms and treatment of imperforate hymen with retained secretions?

Symptoms.—Non-appearance of the menstrual flow; cramp-like pains in abdomen; and tumor in the lower portion of the abdomen, which is usually painful on palpation. Inspection shows the imperforate condition of the hymen.

Treatment.—Aseptic, crucial incision into the hymen, followed by a cleansing douche.

Give the etiology, symptoms, and treatment of stenosis of the cervix.

Congenital causes, as well as uterine displacements, particularly anteflexion.

Symptoms.—Painful menstruation, leukorrhea, bearing-down pains, and sterility.

Treatment.—Dilatation and curetment of the uterus.

What are the symptoms, causes, and treatment of a pudendal hematocele?

Pudendal hematoma is a tumorous condition of the vulva, due to a subcutaneous collection of blood. The *cause* is rupture of a blood-vessel by violence, as by the passage of the head in labor. The swelling has a characteristic purple color, and may be as large as an orange, or larger. The *symptoms* are heaviness, tenseness, and tenderness. The condition must be differentiated from edema of the labia and abscess of Bartholin's glands.

Treatment.—If the tumor is small, and the skin unbroken, the application of cold and pressure; if large, with impending suppuration, incision.

Describe the malformations of the uterus.

The failure of fusion of the Müllerian ducts is the cause. According to the degree of development, various forms are met with. The slightest degrees are those known as *uterus incudiformis* and *cordiformis*. More marked grades are met with, as *uterus septus*, *partitus*, etc., the most marked type being known as *uterus didelphys*.

In uterus bicornis the two tubes unite below, but are separated above. Uterus unicornis results from a lack of development of one of the Müllerian ducts, its fellow developing normally.

Give the etiology, symptoms, and treatment of anteflexion of the uterus.

Pathologic degrees of anteflexion are due to a lack of development of the organ. The *symptoms* are painful menstruation, the suffering beginning just before the flow makes its appearance. The flow is accompanied by the passage of clots. After the flow is well established, the pain becomes much less. Sterility is also sometimes due to anteflexion. The *treatment* consists in thorough dilatation of the cervical canal, together with a curetment.

Give the causes of retroflexion and retroversion of the uterus. Give the differential diagnosis between the two and the treatment of each.

Causes.—Congenital (lack of development); traumatism (falls, blows); parturition; and traction of adhesions in the pelvis.

Diagnosis.—In retroflexion there is an angle to be felt at the junction of the cervix and body, while in retroversion the whole organ is tilted backward.

Treatment.—Reposition of the displaced uterus and the use of a suitable pessary; ventro-suspension; or one of the several operations for shortening the round ligaments.

Define inversion of the uterus, prolapse, and subinvolution of the uterus.

Inversion is the partial or complete turning of the womb inside out; *prolapse* is the falling of the organ below its normal level; *subinvolution* is the persistence of enlargement after parturition.

Give the causes of inversion of the uterus, its diagnosis, and treatment.

Childbirth or the growth of an interstitial or polypoid tumor.

Diagnosis.—In recent case body of uterus projects into vagina, and placenta may be found attached to it; absence of the uterine body on abdominal palpation (cup-shaped depression); the presenting tumor is covered with mucous membrane, and the orifices of the Fallopian tubes may be seen; the tumor is free on all sides except at its upper extremity, around which the cervix may be made out; exploration of cervical canal will show symmetrical reflexion of the mucous membrane upon the tumor.

Treatment.—In the acute variety, immediate reduction. In chronic, attempts at reduction by manual means, by means of elastic bags, or by cutting the constricting cervix.

Give the causes, symptoms, and treatment of subinvolution of the uterus.

Cause.—Parturition (lack of care).

Symptoms.—Backache, headache, pelvic pain, debility, leukorrhea, and menorrhagia.

Treatment.—Repair of lacerations; correction of retrodisplacements of the uterus; cure of endometritis (curetment); and amputation of the cervix.

Give the etiology, diagnosis, and treatment of vulvitis pruriginosa, or pruritus of the vulva.

Causes.—Eczema; irritation from discharges due to disease of the internal organs of generation; thread worms; irritation of diabetic urine; trophic lesions of the nerves resulting from diabetes; reflex irritation of the nerves of the vulva due to pathologic conditions of the internal organs of generation. The congestion of pregnancy sometimes acts as a cause. Idiopathic (cases in which no cause can be found and in which a microscopic examination of the skin and mucous membrane affected shows no changes). The gouty diathesis.

Diagnosis.—This is based on the symptom of itching, which may be so severe that the woman may be practically insane.

Treatment.—Before undertaking treatment it is most important to find the cause, if possible. To do this a complete physical examination is often necessary. If a cause is found, treatment must be directed toward its removal. In any case the diet must be regulated. The *local treatment* consists in keeping the parts dry after urination; the local application of antiseptics and sedatives; cauterization with carbolic acid; spraying of ethereal iodoform into the folds of the vulva; and, finally, excision of affected portions of mucous membrane.

Define and give the treatment of kraurosis vulvæ.

An atrophic condition of the skin of the vulva and external genitals. The skin is thickened, white in color, smooth and shiny, and exhibits numerous small abrasions and fissures. The vaginal entrance is narrowed. The pathologic changes are thickening of the epiderm, disappearance of the rete Malpighii, sclerosis of the corium, disappearance of the sebaceous, and almost complete disappearance of the sweat-glands. The nerves and

nerve-endings are unaltered. The *symptoms* are intense pruritus, dysuria, a feeling of contraction or stretching while walking, and dyspareunia.

The *treatment* comprises the application of astringents and sedatives in the early stages, with complete excision of the affected area when the process has become self-limited.

Give the pathology, symptoms, diagnosis, prognosis, and treatment of specific vaginitis.

Specific colpitis produces a catarrhal inflammation of the mucous membrane, with redness, profuse discharge, and pain. In addition, there usually develop vulvo-vaginal abscess, vulvitis, and urethritis. The disease is most usually found in pregnant women or in young girls. (During the active, non-pregnant, sexual life of an adult woman the mucosa is altered in its epithelium so that it resembles skin and is thus protected against infection.)

The *diagnostic points* are the severity of the inflammation; the involvement of other regions, as the urethra and cervix; and the characteristic discharge. The presence of the gonococcus is conclusive proof, but it is often difficult to find in this region. If gonorrhea is present in its more usual situations (urethra and cervix), it is considered proof positive of the presence of the disease in the vagina.

The *prognosis* is good if the disease is eradicated before upward extension takes place.

The *complications* may be considered to include the local infections mentioned above; but the chief ones to be dreaded are the development of an endometritis, with extension to the tubes and ovaries, and the development of a local peritonitis.

The *treatment* consists in rest in bed, a milk-and-water diet, vaginal douches of permanganate of potassium (1 to 1000) twice daily, followed by the introduction of an argyrol (5-per cent.) tampon for five minutes. This is then withdrawn, and a boroglycerid tampon inserted. In chronic cases various other solutions may be employed, as nitrate of silver (20 gr. to the ounce), with douches of sulfate of zinc and powdered alum.

What is vaginismus? How may it be recognized and what is the treatment?

Vaginismus is a spasmodic contraction of the bulbocavernosus and levator ani muscles, preventing coitus or rendering impossible the introduction of the tip of the index finger in an attempted examination. The affection is a distinct neurosis, and ordinarily there is no disease to be found in the genitalia.

It is to be remembered, however, that any of the painful or irritating affections of the vulva, as vulvitis, kraurosis, pruritus, or urethral caruncle, may be followed by this condition.

Treatment.—A careful examination of the genitalia under ether, if necessary; removal of any cause, as any of the inflammatory conditions noted above, or of any tubal or uterine diseased condition; the application of cocain, followed by the introduction of a small bougie at first, and larger sizes at intervals of a few days. If these measures do not succeed, the power of the muscle must be abrogated by some operative procedure.

Describe vulvo-vaginal thrombosis, and give its pathology, diagnosis, and treatment.

Varices in the vagina may be dangerous if large veins with thin walls are present. Upon the vulva they are always a source of danger if they attain any size. In both situations they should be guarded from injury.

Name the more common varieties of genital fistulæ.

Vesico-vaginal; vesico-uterine; vesico-uterovaginal; and recto-vaginal.

Describe recto-vaginal fistula. Give the etiology and treatment.

Recto-vaginal fistula is a fistulous communication between the rectum and the vagina. The causes are ulceration of carcinomatous, syphilitic, or tuberculous lesions; faulty repair of a rectal tear; the burrowing of pus in a perirectal or pelvic abscess; or the pressure of a pessary. In rare instances labor has resulted in this accident. Traumatisms other than those associated with childbirth also at times act as causes.

The *treatment* consists in attempts to bring about spontaneous healing of recent cases by cleansing the vagina, by the use of laxatives, and by stimulating the sinus with silver salts. Chronic cases are to be operated upon by denudation of the edges of the fistula and the introduction of sutures.

What is a 'tampon'? How is it made and what are the indications for its use? What precautions are to be observed in its employment?

A tampon is a plug of cotton, gauze, wool, or oakum. It is used in obstetrics to control hemorrhage, to dilate the cervix, and in the treatment of certain local conditions in the genital canal. In gynecology it is used as a medium for the application of medicaments and to support the uterus. It is made by tying a piece of string around one of the above-mentioned substances, care being taken to leave one end of the string long enough to enable the patient to remove it after its purpose has been served. When used to check bleeding in the uterus, it is simply a long strip of gauze, which is packed into the cavity of the organ. The chief danger in its use is that sepsis may be caused.

What is caruncle of the urethra?

A small, raspberry-like tumor situated at or just inside the external meatus. It is composed of dilated capillaries, set in a dense stroma of connective tissue, and covered with mucous membrane. It varies in size from that of a pinhead to that of a hickory-nut. It is often erectile in character. The growth bleeds very easily on manipulation and is very sensitive. The most marked symptom is pain on contact. Usually there is hemorrhage, which is rarely profuse. The general health may suffer, and nervous symptoms are often present from loss of sleep. The *treatment* consists in extirpation of the growth.

What are Skene's glands? Give the signs of their inflammation.

Two tubules large enough to admit a No. 1 French probe, lying upon the floor of the urethra, parallel to its course. They are about $\frac{3}{4}$ in. long and situated just inside the meatus.

Generally their inflammation is part of a gonorrheal urethritis and is shown by the exudation of a minute quantity of pus. Rarely the opening may be occluded and a small abscess may be formed without discharge, and as a result there will be a small protrusion at the site of each gland on the floor of the urethra. There is also likely to be a certain amount of gaping of the meatus. These glands represent one of the usual sites for the persistence of gonorrheal infection.

Give the etiology and treatment of an acute general cystitis.

(a) *Predisposing causes:* congestion, retention of urine, abnormalities of the urine, foreign bodies, traumatism, and neoplasms.

(b) *Exciting causes:* The pathogenic organisms most frequently found are the colon bacillus, gonococcus, streptococcus pyogenes, staphylococcus pyogenes, proteus vulgaris, tubercle bacillus, and typhoid bacillus. All these organisms demand some predisposing cause in order to attack the bladder, except the gonococcus and the tubercle bacillus. Channels of infection through which organisms may gain access to the bladder are urethra, ureters, adjacent organs, and the blood.

Treatment.—(a) *General:* rest in bed, milk diet, water in large quantities, laxatives, drugs to render the urine bland and neutral and, later, the use of cubebs, copaiba, etc., baths (general and local), compresses, and suppositories of ichthyol or morphin.

(b) *Local:* irrigation of bladder and direct applications to the cavity of the bladder.

(c) *Operative:* vaginal cystotomy.

Differentiate tuberculous from gonorrheal cystitis and give the treatment for the latter.

Tuberculous cystitis usually follows a tuberculous nephritis, and tuberculous lesions may be found elsewhere in the body; tubercles appear on the bladder and rapidly undergo caseation and ulceration; the urine may contain tubercle bacilli (not always). There is loss of weight and the patient complains of intense pain and tenesmus. In gonorrheal cystitis there is less tendency to ulceration; the urine, although it contains large quantities of pus, retains its acid reaction; gonococci and other signs of the disease are present.

Define 'movable kidney' and give its etiology, symptomatology, diagnosis, and treatment.

One which departs from its normal position. Nephroptosis may be so slight that the organ can only be palpated with difficulty, or it may be so marked that the term '*floating*' is given to it. In the latter condition the kidney may be found in any part of the abdominal cavity.

Etiology.—Wasting of the perirenal fat, associated usually with rapid loss of weight; repeated pregnancies, causing relaxation of the abdominal muscles; tight lacing; traumatism; lifting heavy weights; and vomiting, in those predisposed by loss of perirenal fat.

Symptomatology.—'Movable' kidney is more likely to be attended by marked symptoms than is 'floating' kidney. In the slight forms of displacement usually, and at times in the more severe grades, there may be an entire absence of all subjective symptoms. The principal symptoms are

referable to the digestive tract and to the nervous system. The patients are more or less neurasthenic, complain of digestive disturbances, dragging and sickening pain on pressure in the abdomen, beside spontaneous abdominal pain in the form of *Dietl's crises*—acute attacks of great abdominal pain with nausea and vomiting, chills, fever, and collapse. They are associated usually with a marked degree of mobility. Uterine and pelvic symptoms generally are complained of. Intermittent nephrosis is an occasional occurrence.

Diagnosis.—This is based on the presence of the above-described symptoms and the results of physical examination. With the patient either in the standing position, bending over a chair, or in the recumbent posture, the hands are applied to the abdomen and back, just under the ribs, the patient is told to take a long breath, and by making gentle pressure during inspiration the kidney, if movable, is felt to slip between the hands.

Treatment.—Before beginning treatment make sure that the symptoms are referable to the displaced organ.

(a) *Palliative:* bandage, adhesive strips, or corset, together with the "rest cure." (b) *Operative:* nephrorrhaphy (Edebohls' operation is the most satisfactory).

Give the causes of pelvic inflammation and state its relation to ovarian involvement.

Sepsis or gonorrhea, as a rule. It may occur as a result of exposure to cold during the menstrual period. Pelvic inflammation may result in thickening of the capsule of the ovary, with consequent prevention of rupture of the Graafian follicles and the development of a cystic condition. In septic cases the ovary may be the seat of abscesses due to direct infection of the stroma.

What are the causes and the treatment of pelvic peritonitis?

Causes.—Salpingitis, ovarian inflammation, cellulitis, septic cystitis, metritis, perforation of the uterus, perityphlitis, and appendicitis.

Treatment.—Rest in bed, local use of cold, salines, and hot vaginal douches. Pain to be controlled with heroin, if possible (as little opium to be given as may be); stimulants if needed. If symptoms of inflammation continue for many days, accompanied by the physical signs of exudate, fixation of the pelvic organs, and an irregular temperature; suppuration may be suspected and an operation may be necessary. Operative procedures may be either abdominal or vaginal, according to the conditions present in the individual case.

What are the most frequent etiologic factors in pelvic peritonitis?

It is most often secondary to salpingitis. It may follow ovarian inflammation, cellulitis, septic cystitis, metritis, perforation of the uterus, perityphlitis, or appendicitis.

Why is gonorrhea in women a grave disease?

Because of the danger of involvement of the internal organs of generation and because of the difficulty of eradicating the infection. When the

internal organs are involved, the woman, as a rule, becomes sterile and may be the subject of a variety of inflammatory conditions, with local peritonitis and resulting adhesions. These latter will render her an invalid, even if she is not exposed to risks to her life from the suppurative process.

Give the differential diagnosis of pelvic peritonitis and impaction of feces.

(a) *Pelvic peritonitis:* Local pain, with sensitiveness on pressure above the symphysis and in the vaginal culs-de-sac; fever, usually of a low grade; according to the variety of the lesion, either a distinct mass of exudate or only an increased resistance may be felt in the pelvis by vaginal examination. Local distention and muscular rigidity are present.

(b) *Impaction of feces* shows a mass in the pelvis which is soft and allows indentation to be made. All the other symptoms of pelvic peritonitis are absent.

Give the physical signs of an acute peritonitis.

Tympany; tenderness of the abdomen; fixation of the abdominal muscles; fever; rapid pulse; nausea and vomiting; and lack of peristalsis. There may also be signs of exudate, appreciable by a vaginal examination. The patient has an anxious expression. Abscesses, either general or local, may follow.

Define pelvic hematocele and pelvic hematoma.

Pelvic hematocele is an *effusion of blood into the pelvis*, usually due to rupture of a tubal pregnancy.

Pelvic hematoma is an *effusion of blood into the cellular tissue of the pelvis*. It is frequently caused by traumatism; or it may occur as a complication of pregnancy from rupture of dilated veins. It is often the result of rupture of an extra-uterine pregnancy.

What is a pelvic hematocele? Give the etiology, diagnosis, and treatment.

Pelvic hematocele is an intraperitoneal, encapsulated effusion of blood, due, in the vast majority of cases, to a tubal abortion. Other *causes* are: bleeding from the tubes or ovaries at the menstrual period; regurgitation of blood in gynatresia; rupture of a blood-vessel during an operation; and secondary hemorrhage after operations on the pelvic organs.

The *diagnosis* depends upon the presence of pain, fever, nausea and vomiting, tympany; a feeling that the bladder and bowels must be evacuated, and great difficulty in performing these acts; the signs of internal hemorrhage, and, on examination, the detection of a tumor in the pelvis.

The *treatment* is expectant if the quantity of effused blood is small and signs of absorption soon appear. If, however, there is no tendency to absorption, if there is a suspicion that the hematocele is the result of rupture of an extra-uterine sac, or if signs of suppuration become manifest, an operation is demanded.

Define salpingitis. State its causes and pathology and give the management.

Inflammation of the Fallopian tubes. It may be caused by infection after childbirth or abortion, or by the gonococcus. It may also be caused by the tubercle bacillus. Any form of chronic endometritis tends to its production. It may be simply *catarrhal* or, if the muscular coat of the tube is involved, it may be *interstitial.* On the other hand, the process may extend to the peritoneal covering and adhesions may be produced. The abdominal ostium may be open in the milder forms, but in the severe types of the disease it is closed, and the lumen of the tube is converted into an abscess cavity.

Treatment.—Abdominal section and removal of the tube. Some advise the performance of various plastic operations upon the diseased organs.

What is the differential diagnosis between salpingitis, oöphoritis (chronic), and appendicitis?

The first two are often associated. The differential diagnosis may at times be made by the determination of an uninvolved area between the ovary and the uterus. They are both distinguished from appendicitis by differences in the history and by the different location of the painful area. Moreover, in uncomplicated appendicitis there may be no difficulty in determining by vaginal examination that the pelvic organs are normal.

How is ovarian neuralgia to be diagnosticated?

By the presence of pain in the ovarian regions without the physical signs of ovaritis.

Describe ovaritis.

Ovaritis is of two varieties, acute and chronic. In the former, which may follow infection during delivery or result from gonorrhea, the symptoms are masked by the other symptoms of endometritis, etc.; but if the process is not dependent upon an extension from the uterus (as in those cases due to the specific poisons of cholera, the exanthemata, acute rheumatism, etc.), the symptoms may point definitely to the ovary as the seat of the trouble, and in that case will be those of fever, pain over the ovaries with tenderness on palpation, and rapid pulse. In the *chronic* form the symptoms are pain, more or less constant; menstrual disturbance; sterility; and general reflex disorders.

Pathology.—In the *acute* variety the ovary is swollen and edematous, infiltrated with serum, and showing lymph on its surface. If the condition continues, the organ becomes the seat of small abscesses. In the *chronic* form there is either cystic degeneration of the Graafian follicles, with enlargement of the ovary, or interstitial inflammation, with cirrhosis and diminution in size of the ovary.

How would you differentiate oöphoritis from a lateral uterine fibroma and from salpingitis?

Acute ovarian inflammation is a septic process and can be differentiated from an uncomplicated fibroid tumor by the absence of general symptoms in the latter, as well as by the different relation borne by such a tumor to

the uterus, as compared to that exhibited by an inflamed ovary. In case the fibroid has a long pedicle and becomes rotated, thus causing a twisting of the pedicle, the diagnosis may be impossible. The diagnosis from salpingitis is generally unnecessary, as the tube is involved in a large number of cases; but it may be made, if there is no tubal involvement, by ascertaining that there is a space between the mass and the uterine cornua in the case of an uninvolved tube, while if the tube is involved, the mass is directly continuous with the uterus.

Chronic oöphoritis permits of a satisfactory examination more easily than does the acute variety, and the diagnosis can usually be made without difficulty by the relation borne by the tumor to the uterus and the degree of mobility which the former possesses.

What is the pathology of (a) hydrosalpinx and (b) hematosalpinx? Give the diagnosis and the treatment of each.

Hydrosalpinx is a watery collection in the Fallopian tube and is the result of an old pyosalpinx, the pyogenic membrane having been destroyed and the purulent material, by a process of disintegration and absorption, having lost its original characteristics. *Hematosalpinx*, or blood in the tube, results almost always from an extra-uterine pregnancy.

The *diagnosis* is made by determining the presence of a mass in the pelvis, which is more or less painful and is separate from the uterus. The differential diagnosis is made by the history of the case. The *treatment* of both forms of tubal tumor is removal.

How would a hydrosalpinx be treated, and how a pyosalpinx?

In the case of the former it may be permissible to reopen the abdominal ostium and leave a portion of the damaged structure. In the case of pyosalpinx any such procedure is at best only experimental, and a secondary operation often becomes necessary. The proper treatment is removal.

What are the symptoms of laceration of the cervix?

There are no symptoms of the injury except in some severe tears, in which there may be immediate, profuse bleeding. The *late symptoms* are those due to the results of the injury and not to the injury itself. These results may be: endometritis, endocervicitis, and subinvolution of the uterus. Some believe that reflex changes in the nervous system may be produced by a cervical laceration.

What is acute parametritis? Give its etiology, pathology, and treatment.

An inflammation of the pelvic cellular tissue, in the vast majority of cases of puerperal origin, and always due to infection. The condition is characterized by edema, exudation, resolution, suppuration, or a chronic cirrhosis and thickening of the pelvic cellular tissue. The inflammation is situated in one of the divisions of the pelvic cellular tissue (between the layers of the broad ligament, in the parametrium, paracystium, or paraproctium).

Treatment.—Evacuation of the abscess and prolonged drainage.

Define endometritis and give its causes, varieties, and treatment.

Endometritis is an inflammation of the lining membrane of the uterus. It may be caused by various organisms, and is accordingly divided into: septic, gonorrheal, tuberculous, syphilitic, diphtheritic, and acute infectious (caused by invasion of the specific organism of cholera, typhus fever, influenza, etc.). The most common type of endometritis, however, is the *chronic hyperplastic*, which is not immediately the result of microbic infection; it may have been primarily dependent upon one of the others.

Varieties.—Acute corporeal, usually the result of puerperal infection (associated often with a metritis, a perimetritis, or a peritonitis). *Chronic corporeal*, divided into the interstitial and glandular types.

Treatment.—In the *acute* variety, rest in bed, cold to the abdomen, the use of hot douches, and saline cathartics. Later in the case there may be the extensions mentioned above, which will demand appropriate treatment. The treatment of the *chronic* form consists in the repair of all lacerations of the cervix or perineum, the correction of all displacements of the uterus, and the use of the curet. In certain mild forms it is possible to improve the condition greatly by the use of local depletion to the cervix, together with the application of iodin and glycerin tampons.

Give the symptoms, diagnosis, and treatment of chronic metritis.

Symptoms.—A feeling of weight and bearing-down in the pelvis, backache, irritable bladder, constipation, weakness, and reflex symptoms. Menorrhagia and leukorrhea usually. By vaginal examination the increased size, weight, and firmness of the uterus are appreciated.

Treatment.—Attention to removal of the cause. Thus lacerations of the birth canal are to be repaired, malpositions of the uterus must be corrected, tumors in abdomen or pelvis must be removed, a curetment may be needed, organic diseases of the heart may demand treatment, sexual hygiene may have to be corrected. Local treatment (glycerin tampons, Churchill's tincture of iodin, etc.) may be used to bring about temporary improvement.

What are the most common benign growths found in the cavity of the uterus? Give causes, symptoms, and treatment.

Fibroid polyps, beginning as small interstitial nodules; they become gradually pedunculated.

The *symptoms* are hemorrhage and leukorrhea.

Treatment.—Twist off, if possible, or cut the pedicle; or, if this is impossible, remove piecemeal.

What is the diagnosis of uterine fibroids? Their prognosis and treatment?

The *diagnosis* is based on a study of the symptoms and on physical examination of the abdomen and pelvis. By examination the enlargement and irregular outline of the uterus are determined, and the tumor is proven to be continuous with the uterus and movable with it. As a rule, the tumors are hard (edematous and cystic degenerations are exceptions),

and non-fluctuating. The most important *differential diagnosis* is that between these tumors and pregnancy, which is to be made by exclusion of all the signs of the latter condition. In the cases in which the shape of the uterus simulates the shape of the pregnant organ the diagnosis may be cleared up by a few months' delay, until the absolute signs of pregnancy are available.

Prognosis.—Without operation the woman is often a semi-invalid from the anemia and pressure symptoms, and is, moreover, exposed to the dangers of a fatal issue from the occurrence of degenerative changes, which are very common.

The *treatment* is either a supravaginal hysterectomy or a myomectomy, according to the individual case.

Describe the varieties of fibroids. Give the symptoms and physical signs of each and state their differential diagnosis.

Intraligamentous, interstitial, submucous, and subperitoneal.

The *symptoms* of fibroids are hemorrhage, pain, and leukorrheal discharge. There are also symptoms referable to pressure upon neighboring nerves or other organs, as bladder and rectum, particularly in the case of intraligamentary tumors. The *physical signs* are those of a tumor, determined by vaginal or abdominal examination, according to the size of the growth.

What pathologic changes may occur in fibroids?

Fatty, myxomatous, cystic, and edematous degeneration; lymphangiectasis (caused by dilatation of the lymphatics); telangiectatic or cavernous change (dilatation of blood-vessels); gangrene (in fibroid polyp); inflammation and suppuration; sarcoma and cancer.

What are uterine fungosities? Give their symptoms and treatment.

Uterine fungosities are due to a condition of hypertrophy of the endometrium of an extreme degree. They constitute a mixed form of glandular and interstitial endometritis.

Symptoms.—The menstrual flow is increased in quantity, as well as in frequency; there is an increase in the leukorrheal discharge; the pain is worse at the menstrual period, and nervous symptoms are present.

Treatment.—Repair of any lacerations of the cervix or perineum, correction of malpositions of the uterus, and curetment.

Name the most usual neoplasms of the ovaries.

(a) *Parenchymatogenous:* simple serous cysts, serous and pseudomucin cystadenomata, carcinomata, dermoids, and teratomata. (b) *Stromatogenous:* fibromata, fibromyomata, sarcomata, endotheliomata, angiomata, enchondromata, and myomata.

What are the diagnostic points of an ovarian tumor?

In the earlier stage, when the tumor is still within the pelvic cavity, a mass is felt which is separate from the uterus, and sometimes the fluid nature of the contents may be made out. If the tumor is intraperitoneal

and pedunculated, it can be pushed up into the abdominal cavity. When the tumor has grown up into the abdomen, the diagnosis depends upon the vaginal examination—to determine the area of the abdomen in which it originated, and the abdominal examination to determine its characteristics. By palpation and percussion the fluid nature of the tumor is discovered. The tumor presents a central area of dulness, surrounded by a zone of tympany, and these signs remain the same when the position of the patient is altered. The important conditions from which an ovarian tumor must be differentiated are: cyst, phantom tumor, deposition of fat in the abdominal wall, and pregnancy. The distinction is made by carefully determining the size, relations, and condition of the uterus. If necessary, the patient should be anesthetized for the examination.

Give the symptoms of an ovarian cyst. What is the treatment?

If the tumor is *intraperitoneal*, there will very likely be no symptoms until it has reached a size sufficient to be palpated above the symphysis. If it is *intraligamentary*, or *impacted in the pelvis*, there will be, at an earlier stage, the development of pressure symptoms referable to the bladder, rectum, or lower extremities. Pain is not a constant symptom. Pressure upon the ureters is a common symptom. Ascites, amenorrhea, or menorrhagia may be noted. An abdominal or combined examination will disclose a tumor distinct from the uterus, and percussion by an assistant will reveal the presence of fluid.

The *treatment* is removal as soon as the diagnosis is made, because of the danger of the tumor's undergoing one of the various forms of degeneration.

Name the varieties of ovarian cyst and give a description of them.

Follicular.—Originate in ovarian follicles and are due to some cause which prevents the rupture of a mature follicle. They are usually bilateral. The growth is limited and usually does not exceed the size of an egg. The contents are usually clear serum.

Glandular (*Multilocular Ovarian Cysts or Ovarian Adenomata*).—The outer surface is smooth and glistening in appearance, and often lobulated. The wall is composed of fibrous tissue containing elastic and unstriped muscular fibers. The ovary is early destroyed. At first the cyst is multilocular, but it tends to become unilocular. The contents vary from a thin, colorless fluid to a black, jelly-like substance. Growth is unlimited and rapid. The tumor is usually unilateral, and intraperitoneal in development. The Fallopian tube is distinct from the tumor and not much, if at all, elongated.

Dermoid.—Dermoid cyst, characterized by the presence of skin and cutaneous appendages; usually moderate in size; usually unilateral; primarily unilocular. The color is dull yellowish or brownish. The lining membrane resembles the skin in structure. All the cutaneous appendages are found in these tumors (hair, teeth, nails, etc.). Bone, unstriped muscle tissue, and a substance resembling brain are sometimes found. The contents vary from a thick, oily fluid of a yellowish or brown color, to a pultaceous, semisolid mass.

Paroöphoritic (*Papillomatous*) *Cysts.*—Warty growths found upon the inner surface. The contents are usually clear and of a watery consistence, the color varying from a light yellow to a dark brown. Often bilateral. Smaller and of slower growth than the glandular cysts. Perforation of the wall by the papillomata, with invasion of the peritoneum, is usually seen early. The Fallopian tube is more likely to be involved than in oöphoritic cysts.

Parovarian.—(a) *Simple:* thin-walled, of a light yellowish or greenish color, with ramifications of small vessels upon the surface. The contents are clear opalescent fluid. (b) *Papillomatous:* the walls are thicker than in the simple form, the contained fluid is not so clear, and there may be altered blood. The inner surface of the cyst wall is covered with warty growths similar to those found in paroöphoritic cysts. They are liable to all the accidents of the former variety.

Both types of parovarian cyst are of small size and slow growth. The ovary is not affected. The Fallopian tube becomes greatly elongated and is stretched over the surface of the cyst.

What is the differential diagnosis between ascites and ovarian cyst?

In *ascites* the abdomen generally shows a bulging in the flanks, with flattening at the apex of the enlargement, when the patient is recumbent; there is dulness in the flanks, with resonance anteriorly; the physical signs are greatly affected by change in position.

In *ovarian cyst* there is a distinctly more spherical shape to the swelling, the abdomen being more prominent anteriorly, while the bulging in the flanks is absent. Dulness is found over the anterior portion of the tumor, while in the flanks and above the growth there is resonance, and these findings are not affected by change of posture. A distinct wall can often be felt. Vaginal examination often reveals the point of origin on one side, and the uterus in the presence of a cyst is often displaced.

Give the differential diagnosis between a hydronephrosis and an ovarian cyst.

If an accurate history is obtainable, the direction of the growth of the swelling (from above downward), its association with some renal symptoms, the relation to the colon, and the negative results of a combined abdominal and pelvic examination will establish the diagnosis. The presence of a lumbar tumor which varies in size, the variations being associated with marked changes in the quantity of urine, is almost positive proof of a hydronephrosis.

Give the etiology, symptoms, and treatment of cysts of Bartholin's glands.

The *cause* of vulvo-vaginal cysts is a retention of the glandular contents, usually as a sequence of inflammation. The *physical signs* are those of a tumor at the base of the labia minora, just beneath the mucous membrane of the vagina. The tumor may attain the size of the fetal head.

A differential diagnosis is to be made between this condition and inguinal hernia, hydrocele of the canal of Nuck, cyst of the round ligament, and sacculated cysts of old hernial sacs by the fact that in all the foregoing

conditions the tumor lies more in the upper and outer part of the labium majus, and extends to, and may be connected with, the external ring.

Treatment.—Extirpation of the cyst or free incision and packing. The former is the method of choice if there has been no inflammatory process binding the wall of the cyst to the surrounding parts.

Give the physical signs of cancer of the uterus in the early stage.

There may be none, the diagnosis depending upon the symptoms and a microscopic examination. Often, however, there will be found a reddened cervix, bleeding on the least irritation, together with a sclerotic condition of the cervical tissue due to the cellular infiltration.

The treatment of cancer of the uterus in the early stages is a complete hysterectomy; in the late stages this operation offers no hope and a palliative cauterization and curetment should be substituted.

What are the symptoms of cancer of the uterus?

Menorrhagia or metrorrhagia, no matter how slight, are danger signals at the time of menopause. Any increase of leukorrhea is also suspicious. The *late symptoms* are the above, plus a foul discharge and cachexia, with pain as a variable factor.

Without the aid of the microscope can cancer of the uterus be discovered?

Yes, in the advanced stages. It is to be borne in mind, however, that an early diagnosis is of paramount importance, and, therefore, all suspicious cases should be subjected to microscopic study at the earliest possible moment.

What diseases are most likely to be mistaken for cancer of the uterus?

Sarcoma, syphilis, and tuberculosis of the cervix, and sloughing fibroid of the uterus. Senile endometritis may also cause doubt.

What is the treatment of tumors of the mammary glands?

For a short time external applications, such as ointments of belladonna and ichthyol, may be employed; but if immediate improvement and disappearance do not occur, a portion of the growth is to be excised and examined under the microscope. If there is no possible doubt, after the examination, that the growth is benign, it alone may be removed; but if there is the least suspicion of malignancy, complete amputation of the breast is to be performed.

Describe Sims' position.

The latero-abdominal position is as follows: The patient lies upon a table upon her left side. The side of the face is upon a pillow; the left arm is behind her back, so that the left breast rests upon the table. The thighs are flexed upon the abdomen at an angle of about 90° to the trunk. The right thigh is more flexed than the left, so that the knee on the right side may touch the table above the left knee. The legs are flexed on the thighs.

Define plastic operations as applied to gynecology.

The operations usually designated by this term are those for the repair of the cervix and perineum, operations for the reduction of cystocele, and certain conservative operations upon the tubes and ovaries. They are those operations which have as their aim the moulding or modeling of a part which has been injured into a correct anatomic condition.

Describe the preparations necessary for an aseptic gynecologic operation in private practice.

All water and instruments must be sterilized by boiling. A sufficient number of sheets and towels and, if an abdominal section is to be performed, of sponges must be sterilized. The patient must be prepared for operation by attention to the bowels and urine, and cleansing of the field of incision. A suitable table with its dressings must be procured, and preparations must be made for combating shock by the means of hot water bags, diffusible stimulants, and the necessary appliances and instruments for hypodermoclysis.

What methods should be employed to dilate the non-pregnant uterus? What are the indications for the operation?

Most careful asepsis; anesthesia; Goodell's, Wathen's, or some other steel instrument. The operation is required whenever the uterus needs to be cureted, and in cases of stenosis of the cervix giving rise to dysmenorrhea.

What are the symptomatic indications for curetage? Give the steps of the operation.

Uterine bleeding due to retained products of conception, to cancer (if inoperable), to fibroid tumors (if operation is contra-indicated); endometritis; subinvolution.

The strictest asepsis is to be observed. The cervix is caught with a double tenaculum, and dilatation is performed, if needful. The uterus is douched, and then the curet is employed. The aim should be to remove the mucous membrane in strips from the fundus to the internal os. When the procedure is employed in puerperal cases, great care must be exercised not to use undue force. In the other indications considerable force is needed. The danger of perforating the uterus must always be remembered, particularly when the instrument is first introduced. After the operation is completed another douche is given and, if desired, a piece of gauze is inserted into the cavity of the organ to act as a drain.

How is a lacerated cervix repaired? How is a lacerated perineum repaired?

The tissue outside of the canal of the *cervix* is cut away and the sutures are introduced from the edge of the vaginal surface of the cervix through the cervical mucous membrane, again passing through the mucous membrane of the anterior lip and emerging at the edge of the vaginal surface of the upper or anterior cervical lip; the operation is repeated on the other side of the cervix and the sutures are tied or shotted, great care being taken to secure accurate apposition of the wound edges.

The *perineum* is usually best repaired by the performance of Emmet's operation. The most prominent point of the rectocele, which will easily

reach to the orifice of either vulvo-vaginal gland, is seized and drawn sharply to one side while a tenaculum is caught at the apex of the triangle thus formed. The tissue in the area of this triangle is denuded and the other side of the vagina is treated in the same way. Sutures are then introduced, care being taken to include the muscle in the outer bite of the needle. After the requisite number of lateral sutures have been inserted the external perineum is closed by two "crown" sutures.

How should the operation of shortening the round ligaments of the uterus be performed?

Alexander's operation is done without opening the general peritoneal cavity, the field being the inguinal canals. At the present time many prefer the intra-abdominal method, in which a median incision is made and the ligaments are plicated in various ways.

Give the relative indications of Alexander's operation and the operation of intraperitoneal suspension to the abdominal wall.

Alexander's operation is only to be used when the uterus is freely and easily replaceable. It interferes less with subsequent pregnancy, it is claimed, than any other operative procedure. Ventral suspension, on the other hand, can be used in all classes of cases and is, therefore, the operation more often employed.

Is ventrofixation of the uterus ever justifiable? How is the operation performed?

Yes, in women who have passed the child-bearing age. The uterus is scarified and attached to the muscles of the abdominal wall. A larger bite of the muscle is taken than in the suspension operation, and some operators include the fascia.

What are the relative advantages and disadvantages of the abdominal and vaginal routes in pelvic surgery?

The abdominal route gives a greater chance to remove injured structures safely. It is associated with much greater shock than the vaginal. There is risk of hernia in the abdominal route. Hemostasis can be much more safely secured by the abdominal than by vaginal operation. In collections of pus in the pelvis, particularly if the patient is in a weakened state, the vaginal route is by far the preferable as a primary procedure, in order to evacuate the pus. At a later time it may become necessary to operate by the abdominal incision.

What are the indications for the performance of hysterorrhaphy? Describe the operation briefly. What are its advantages?

A retrodisplacement of the uterus. If the organ is mobile it may be replaced and a pessary inserted; but, unless the woman can be kept under observation continuously, operative treatment is to be preferred. If the organ is adherent and there are symptoms referable to the malposition, there is an absolute indication for hysterorrhaphy.

A small, median incision is made just above the symphysis. Two silk sutures are introduced through the inner edges of the recti muscles (some

do not include any muscle) and the peritoneum on one side of the wound, then through the fundus of the uterus between the uterine cornua. They are then passed through the same structures on the other side of the wound and tied. The abdominal incision is closed by the layer method, with one through-and-through suture to prevent the formation of a "dead space."

The advantages are that the course of subsequent labors is not interfered with, as is the case in some of the other methods of ventrofixation, shortening the uterosacral ligaments, etc. Another operation of value is Edebohls' modification of the Alexander-Adams, which shortens the "round ligaments" in the inguinal canals. This latter operation, however, is not applicable to those cases in which there is a fixed displacement of the womb or any other complicating condition.

What are the indications for hysterectomy? Give the technic for vaginal hysterectomy.

Fibroid tumors, carcinoma of cervix or fundus, bilateral salpingo-oöphorectomy (complete), and rare cases of puerperal sepsis. The technic of a vaginal section consists in the exposure of the broad ligaments by separation of the vagina and peritoneum from the uterus and the use of either clamps or ligatures to secure the vessels. The uterus is then removed either as a whole or in sections.

What are the advantages of a supra-vaginal amputation of the cervix over a panhysterectomy?

It is a shorter operative procedure; there is less danger of infection and hemorrhage. It is, therefore, the operation of choice in all cases in which it is applicable. It cannot be used in any case of malignant disease or tuberculosis of the uterus.

What preparatory and postoperative treatment should be instituted to secure the best results after laparotomy?

At least one day's rest in bed before the operation; free catharsis; liquid diet on the morning of the operation; careful sterilization of the operative field; catheterization before making the incision; examination of the urine; examination of the heart and lungs; and careful anesthesia. After operation the employment of hot bags, transfusion of normal salt solution, if indicated to combat shock; close attention to detect the earliest signs of any peritoneal or other infection; the administration of calomel in divided doses; liquid diet until the bowels have moved satisfactorily; sufficient time in bed to allow for union of wound.

Describe an abdominal hysterectomy.

A median incision is made and the peritoneal cavity opened. The ovarian artery is ligated at the uterine cornu and also near the pelvic wall. A separate ligature is placed upon the round ligament. The broad ligament is then cut down to the point of reflection of the peritoneum from the uterus to the bladder. The same steps are repeated on the other side. The peritoneum is separated from the uterus at its point of reflection and it is then pushed down until the tissue above the cervix is exposed. The uterine arteries are then ligated close to the cervix (in order to avoid tying the ureter). If the cervix is not to be removed (supravaginal amputation) the uterus is now amputated by cutting across the cervix. If a complete

or panhysterectomy is to be performed, the vagina is opened after tying the uterine arteries, and the whole organ is removed by continuing the incision around the cervix as close to it as possible. Either the cervix or the vaginal walls are united, as the case may be, and the peritoneum is closed over this first line of sutures. Suturing the abdomen completes the operation.

What are the diagnostic symptoms and signs of pelvic inflammation in the female and under what conditions would operation be necessary?

The *symptoms* are the same, whether the cause is a tubal or ovarian inflammation, or a suppurative condition in the pelvic connective tissue. They are (a) pain in lower abdomen and pelvis, radiating down the thighs; rise in temperature; rapid and weak pulse; anorexia; prostration; and chills. If there is no peritonitis present, there will be no vomiting or nausea or distention of the abdomen.

The *diagnosis* is made by an abdominal and pelvic examination. It is to be remembered that it is impossible to distinguish between a suppurative cellulitis due to tubo-ovarian disease and one due to other causes. On examination pain will be experienced by the patient, and this symptom, together with increased resistance, may be the only sign aside from the symptoms given above. A mass may, however, be felt if the pain is not so severe. This mass may either be the tube distended with pus and associated with the ovary, or it may be a mass in the connective-tissue of the broad ligament, or of the area behind or in front of the uterus. In chronic cases the mass may be the tube and ovary bound together by adhesions, with or without the presence of pus.

Operation is demanded in the presence of pus collections in the cellular tissue. If possible, the evacuation should be made by the vaginal route. Operation is also indicated in the condition known as "pus-tubes." In the old chronic cases in which there is great pain an operation offers the only relief, and in certain cases there is a possibility of performing the so-called "conservative" procedures, *i. e.*, removing only the more evidently diseased portions.

Which route is to be selected, the suprapubic or the vaginal, in cystotomy in the female? What is the technic of the operation?

The vaginal. After carefully cleansing the vagina a sound is passed into the bladder and its point brought against the anterior vaginal wall. An incision is then made, cutting down upon the end of the sound, and the opening is further enlarged to give free drainage. The incision is to be made in the median line. If it is desired to have the opening remain patulous for a considerable time, the mucous membrane of the bladder is stitched to that of the vagina. If this is not done, the fistulous opening will close very soon.

Give the causes of calculus in the female bladder, the most common varieties, and the different methods of treatment.

The phosphatic is the more usual variety in women. Causes are vesicovaginal fistula; diverticula; foreign bodies introduced through urethra or, rarely, from other organs; and kidney gravel (rarely).

PATHOLOGY

What is understood by the terms pathologic physiology, pathologic morphology, special pathology?

Pathologic physiology is that branch of science which deals with the study of disturbances of function in disease.

Pathologic morphology is that branch of science which deals with the study of the structural changes in disease.

Special pathology deals with pathologic processes in individual or special diseases, organs, or parts.

Describe the incisions necessary to expose the brain for examination postmortem.

An incision is made through the scalp from ear to ear and the flaps dissected forward and backward. The cranium is divided by a circular incision with a saw, passing through a point 3½ inches above the bridge of the nose and through the occipital protuberance, and the dura mater cut through with a knife; or the skull-cap may be wrenched off with a stout hook, without dividing the dura mater. The falx is divided between the anterior lobes and the membrane drawn back.

Describe in detail the usual mode of making a postmortem examination of the brain.

The anterior, middle, and posterior cerebral, basilar, and carotid arteries having been examined for emboli, thrombi, atheroma, and aneurysm, the two halves of the cerebrum are separated, exposing the corpus callosum, which is divided by a longitudinal incision down to, but not through, the ventricle. The incision is then prolonged backward and forward so as to expose the cornua. The hemispheres are divided by a number of longitudinal incisions, from the lateral ventricles nearly to the pia, into a number of prism-shaped pieces, held together by a thin layer of cortex. The fourth ventricle is opened by a longitudinal incision through the vermiform process, each cerebellar hemisphere divided by an incision through the upper and inner convex border and subdivided by further incisions in the same direction. The cerebral ganglia are explored by making a series of thin transverse sections, commencing in front, and, finally, the same procedure is applied to the medulla.

In what order are the organs of the thorax and abdomen best examined at a postmortem section?

General inspection of the abdominal cavity—presence of serum, inflammatory lesions, perforations; invagination, incarceration, or hernia; condition of the appendix and intestines generally; liver, stomach; height of the dia-

phragm. Examination of the heart and pericardium. Inspection of the pleural cavities. Examination of the lungs, pharynx, larynx, esophagus, and thyroid gland. Examination of the kidneys and suprarenal bodies, spleen, intestines, stomach, and duodenum, liver, pancreas, thoracic duct, solar plexus, aorta, genito-urinary organs.

What postmortem changes occur in the tissues?

Cadaveric lividity or hypostasis; putrefactive changes (greenish discoloration); cooling (algor mortis); rigor mortis; formation of adipocere; petrifaction.

Discuss cell-division and growth.

Cell-division takes place in two ways: (a) *direct* or *amitosis*, and (b) *indirect* or *mitosis* (karyomitosis, karyokinesis). Indirect division is accomplished by certain complicated changes in the filamentary substance of the nucleus, called chromatin or mitome. Three phases are described:

1. *Concentration.* The chromatin substance, arranged in the form of U-shaped loops, is gathered into a contorted coil, called *spireme*, and the nuclear membrane disappears. The *centrosome* divides and the segments pass to opposite parts of the cell (polar bodies). The threads of the spireme break across and form the *chromosomes*. In man the number is said to be 16; according to some authorities, 32. The figure is now called the *mother star* or *monaster*.

2. *Longitudinal splitting of the chromosomes.* Each chromosome splits lengthwise into exactly equal parts, which separate into groups and collect around the two polar bodies, forming the *diasters* or *daughter stars*.

3. Division of the cell body and formation of new nuclei about the daughter chromosomes. The centrosome may disappear or remain in the cytoplasm beside the new nucleus. A nuclear membrane is formed and two independent cells, each with a nucleus, are produced.

Name the more common tissue alterations that accompany fever and explain why.

Increased oxidation and tissue waste resulting in increased heat-production. The quantity of nitrogen excreted in the urine exceeds that contained in the food, and emaciation results. The specific gravity of the blood is increased, and the alkalinity is reduced by various acids produced in the increased tissue-destruction. These changes are due in part to the increased temperature and in part to toxins circulating in the blood. The muscles, heart, liver, and kidneys are the seat of cloudy swelling, fatty degeneration, and coagulation necrosis, probably due to toxins.

What is the cause of a rise in temperature? Explain the mechanism.

In most cases fever is caused by the presence of toxic substances in the blood acting upon the heat-centers. These substances may be bacterial poisions, metabolic products, such as albumoses or peptones, or ferments—pepsin, fibrin-ferment, diastase. Rarely fever is due to direct exposure to heat, as in sunstroke, in which, however, toxins are also produced and affect the heat-centers secondarily; or to direct action on the centers, as in hysteria.

Describe the pathologic conditions in hectic fever.

An infectious or suppurative process somewhere in the body. The most common bacterial causes are pyogenic microörganisms and B. tuberculosis.

What disease of the mother may be transmitted to the fetus?

Small-pox, measles, syphilis, typhoid fever, pneumonia, tuberculosis, malaria.

Enumerate the most ordinary senile changes that occur in the various tissues of the body.

Atrophy and loss of elasticity of the skin; arteriosclerosis; atrophy of the heart and interstitial myocarditis; increased deposition of lime salts in the bones and tendons; ankylosis and deformity of the joints.

Distinguish between burns inflicted on a body before death and those inflicted after death.

The burned area is covered with vesicles or blebs, with red inflammatory bases and surrounded by an inflammatory zone; or suppuration may be present. These changes are not observed in burns produced after death.

What is the cause of death following burns?

Autointoxication. The changes are albuminous degeneration of liver and kidneys; focal necrosis of spleen, which is swollen, and bone-marrow; capillary thromboses; interstitial hemorrhages in the kidney.

HYPERTROPHY AND ATROPHY

Name some of the causes of active hyperemia and give illustrations.

1. Mechanical (a blow), thermic (extreme heat or cold), and chemical (drugs, *atropin* internally, *iodin* locally) agencies acting on the muscular coats of the arteries.

2. Nervous influences, either stimulation of vasodilators—*neurotonic hyperemia*—or paralysis of vasodilator nerves—*neuroparalytic hyperemia.* Migraine furnishes a clinical example.

3. Obstruction in the circulation of a neighboring organ or part—*collateral hyperemia.* Example: obstruction of one renal artery produces hyperemia of the other kidney.

Describe hypertrophy and give its etiology and pathologic anatomy.

An increase in the size of a tissue or organ independent of the general growth of the organism. Hypertrophy may be *true* or functional (compensatory), or *false* (pseudohypertrophy).

True hypertrophy affects both parenchyma and interstitial tissue; the outline is preserved, and function is increased. The cause is increased functional demand either direct—pregnancy; or indirect, owing to imperfect action of another organ—compensatory enlargement of one lung when the other is diseased. *False hypertrophy* affects the connective tissue chiefly

or exclusively, the parenchyma usually atrophies, the shape and consistency of the organ are altered, and function is diminished. Examples are hypertrophic cirrhosis of the liver, pseudohypertrophic muscular paralysis.

Causes: Increased functional activity. Congenital disposition. Intermittent pressure (corns, callosities on the palms). Trophic disturbances in certain nerve lesions. Functional disturbance of some of the ductless glands—the thyroid, thymus, pituitary body (acromegaly).

Define atrophy. Give the varieties of atrophy.

A diminution in the bulk of one or more of the component parts of an organ, with diminution of functional activity. The varieties usually described are: *simple*, due to defective nutrition—general, or defective blood-supply—local; *senile* (physiologic); atrophy from disuse; *pressure* (constant, as the pressure of an aneurysm on bone); *neuropathic*, due to loss of trophic influences in paralytic affections. The last is a degenerative process. *Brown atrophy* occurs in chronic congestive states, especially in the heart and liver.

DEGENERATIONS

State the difference between degeneration and infiltration. Illustrate.

Infiltration consists in the deposition in the cell of an abnormal substance or of a normal constituent in excess; the nucleus and cytoplasm are not destroyed. Degeneration is the conversion of the cytoplasm into an abnormal substance; the nucleus and cytoplasm are destroyed. (See below, Fatty Degeneration and Fatty Infiltration.)

a. Define fatty metamorphosis. b. Give its terminations.

(a) The conversion of the cellular protoplasm into fat.
(b) Liquefaction; caseation; total destruction of cells or necrobiosis.

Differentiate fatty infiltration and fatty degeneration.

In the former the fat is deposited in the cell, crowding the nucleus to one side without destroying it, and distending the cell. The fat appears in large droplets. In fatty degeneration the cytoplasm and the nucleus are converted into fat and the cell eventually becomes a sac filled with fatty detritus. The fat appears in the form of granules or very small droplets.

Discuss fatty degeneration, explaining of what it may be a symptom when affecting parenchymatous cells.

A retrograde metamorphosis in which the proteid elements are converted into fat. The cells are completely filled with fat-granules and droplets; the nuclei are destroyed. Fatty degeneration occurs chiefly in the liver, kidney, walls of the blood-vessels, and myocardium (fatty heart). The causes are diminished blood-supply, fevers, and poisons, which interfere with oxygenation. It occurs in the anemias, the cachexia of cancer, tuberculosis, and syphilis, hypertrophy of the heart with insufficient blood-supply (local anemia) in fevers, yellow fever, and in cases of poisoning with phosphorus, bichlorid of mercury, arsenic, carbon monoxid, iodoform, etc.

Give a general explanation of the pathology of edema and include its chief factors.

Infiltration of the tissues and serous cavities of the body with a serous fluid.

The *pathologic causes* are: (1) obstruction of the veins and lymphatics; (2) changes in the composition of the blood (anemia); (3) disturbances of metabolism; (4) changes in the blood-vessel walls.

The *clinical causes* are: heart disease, cirrhosis of the liver, diseases of the kidneys, anemia, cancerous and tuberculous cachexia, nervous disturbances (hysteria).

Give the causes of edema.

See previous question.

Define the term general anasarca and give a gross pathologic description of the lesion which usually gives rise to it.

Serous infiltration of the general subcutaneous connective tissue throughout the body.

Chronic parenchymatous nephritis. The kidney is large, flabby, and pale; the capsule strips readily; the cut surface presents a mottled appearance, yellow areas of fatty degeneration alternating with red, hemorrhagic areas. The kidney of chronic parenchymatous nephritis is called the *large white kidney.*

Name the albuminoid degenerations.

Amyloid, hyaline, mucoid, and colloid.

Describe amyloid degeneration and state in what cases and in what organs it is found.

Amyloid degeneration or infiltration affects chiefly the intima of small blood-vessels and is characterized by the formation of an albuminoid substance giving a characteristic reaction in the cells and intercellular substance. The most frequent seats are the liver, kidney, and spleen (sago spleen), walls of the intestines, heart, and large blood-vessels, nervous system, and prostate gland. The cut surface of organs has a waxy or bacony appearance. It is still under dispute whether the process is a degeneration or an infiltration, and whether it ever affects parenchyma cells.

How would you recognize amyloid degeneration?

Iodin and sulfuric acid applied to amyloid material gives the amyloid reaction, which consists in a blue color. With Lugol's solution a reddish-brown color is produced, contrasting with the yellowish or greenish brown of the healthy tissues.

What glands are most frequently affected by amyloid degeneration?

Liver, spleen, kidneys, prostate, and lymph-glands.

What varieties of degeneration may occur in lymph-glands?

Hyaline, amyloid, and fatty degeneration; calcareous and pigmentary infiltration.

Hyaline degeneration—give its etiology and seats.

A degeneration affecting connective tissue, especially the walls of blood-vessels, with the production of a material resembling amyloid but not giving the same reactions. *Causes:* old age; acute infectious diseases; chronic inflammation (sclerosis); tumors (cylindromata). *Seats:* The blood-vessels of the brain, kidney, heart, ovary, and lymph-glands.

What is fibrinous degeneration?

Synonymous with coagulation necrosis (*q. v.*).

Necrosis—distinguish between the coagulation and liquefaction forms, with example of each.

Coagulation necrosis is characterized by the production of fibrin, the fibrin-ferment being supplied by the broken-down cells. *Example:* The diphtheritic or "false" membrane in diphtheria.

In *liquefaction necrosis* the intercellular substances break down and form fluid or pus, the cells floating in the fluid; no coagulation takes place. This form is often the terminal stage of other forms of necrosis. *Examples:* Acute softening of the brain after embolism; the vesicles following a burn.

a. What is mucoid degeneration? b. What is colloid degeneration?

(a) The conversion of epithelial cells (mucoid degeneration) and connective tissue (myxomatous degeneration) into a viscid substance containing *mucin.*

(b) The conversion of epithelial cells into a gelatinous material which resembles mucin but does not give the same reactions.

Mucin is insoluble, but swells in water; it is precipitated by alcohol and acetic acid. *Colloid material* does *not* swell in water and is *not* precipitated by alcohol and acetic acid.

Discuss (a) caseation; (b) calcification.

(a) A process similar to coagulation necrosis, due to invasion of the tissue by the tubercle bacillus. It affects both cells and intercellular substance, which are converted into a formless mass of granular—so-called cheesy—débris, surrounded by nuclei in various stages of degeneration, and an inflammatory zone. The process terminates in liquefaction and absorption, or calcification and encapsulation.

(b) The deposition in tissues other than bony tissue of earthy salts, chiefly the carbonates and phosphates of calcium and magnesium. Calcification occurs in tissues with deficient blood-supply and is found chiefly in cartilage; the connective tissue of blood-vessels (aorta, valves of the heart, especially the aortic); tumors; encysted parasites; necrotic foci; infarcts; thrombi and emboli (phleboliths); ganglion cells of the nervous system; and in the form of biliary, renal, vesical, and intestinal calculi (enteroliths).

What is calcific metamorphosis?

The transformation of cells into a calcareous or mineral substance.

THE BLOOD

Define anemia, hyperemia, leukemia.

Anemia—any reduction in the quantity or quality of the blood, affecting the cellular elements or hemoglobin or both.

Hyperemia—an excess of blood in a part.

Leukemia—a primary anemia due to disease of the blood-making organs and characterized by very great leukocytosis, oligocythemia and oligochromemia, and by pathologic changes (hyperplasia) of the bone-marrow, spleen, and lymph-glands.

What pathologic changes take place in the blood-plasma?

Hypertonicity—increased salinity; hyperinosis and hypinosis—increase and decrease in the fibrin-forming substances; hydremia and anhydremia—increase and reduction in quantity of water in the blood; lipemia—the presence of free fat; melanemia—the presence of pigment; hemoglobinemia, methemoglobinemia—the presence of hemoglobin in solution in the plasma.

In what general respects do 'anemia' and 'progressive pernicious anemia' differ?

The term anemia properly includes all conditions in which the blood is impoverished, but is generally used to designate simple or secondary anemia. Pernicious anemia is a primary anemia characterized by oligocythemia and terminating in death.

Describe the appearance of the blood in a case of pernicious anemia.

The characteristic change is reduction of the number of *red cells*—oligocythemia—to 1,000,000 or less in a cubic centimeter. The cells are altered in size (microcytes and macrocytes—anisocytosis) and shape (poikilocytosis). Nucleated cells, normoblasts, and megaloblasts are present. The *leukocytes* are diminished or normal until the terminal stage, when leukocytosis is present. The *hemoglobin* is reduced in proportion to the reduction of red cells, or somewhat less. The *color index* is 1 or higher.

What condition of the blood is generally prominent in all forms of rheumatism?

Simple or secondary anemia and leukocytosis. The coagulability is increased—hyperinosis.

How are secretions affected in anemia?

The urine may be diminished or increased in quantity and also in its solid constituents. Hydrochloric acid in the stomach is increased in chlorosis, but diminished or absent in pernicious anemia.

(a) Define leukocytosis and give its two varieties. (b) What does a leukocytosis with a predominance of polymorphonuclear leukocytes indicate? (c) What condition of the blood is found in chlorosis?

(a) The examiner probably expects the answer "physiologic and pathologic" leukocytosis. The former is observed during digestion, after a cold

bath, during pregnancy, and during the first days of life. It is usually moderate. *Pathologic* leukocytosis occurs in a number of infectious diseases —except typhoid fever, typhus fever, influenza, malaria, measles, and tuberculosis—and in any inflammatory condition associated with exudation and suppuration.

Leukocytosis is now subdivided into:

1. *Polynuclear leukocytosis* or simply leukocytosis, when the polynuclear or polymorphonuclear neutrophile leukocytes only are increased.

2. *Lymphocytosis:* An increase of the mononuclear lymphocytes chiefly.

3. *Mixed leukocytosis:* An increase of several forms, with but little disturbance of the normal proportions. Myelocytes are found in the blood.

4. *Eosinophilia:* An increase of the eosinophile cells only.

(b) The presence of an infectious disease; inflammation and suppuration in some portion of the body; cachexia (cancerous, syphilitic).

(c) Moderate reduction and variation in the size and shape of the red cells, with disproportionate diminution of the hemoglobin. The leukocytes are not increased; the color index is low. In severe cases nucleated red corpuscles are seen.

Explain what is meant by the terms physiologic and pathologic leukocytosis respectively. State whether a leukocytosis is present in the following diseases: typhoid fever, malarial fever, appendicitis, acute miliary tuberculosis.

See previous question.

Leukocytosis may or may not be present in appendicitis; as a rule, the leukocytes are increased in the suppurative and gangrenous forms. It is absent in the other conditions mentioned.

Name some of the changes which occur in extravasated blood.

1. Coagulation, followed by absorption of the fluid elements and deposition of blood-pigment, which is also eventually carried off by the lymphatics. The tissue destroyed by the hemorrhage is replaced by connective tissue.

2. Organization—the coagulated blood is replaced by fibrous tissue.

3. Cyst formation—instead of being absorbed, the fluid portion may remain as a cyst.

4. The blood, especially in serous cavities, may become infected and undergo suppuration.

5. Calcification (rare).

What is ischemic paralysis?

Loss of power in a part from local anemia. The blood-supply to the nerves of the part is abolished.

What is an embolus? Mention frequent sources of emboli. State the sequels of embolism.

Embolism is the obstruction of a blood-vessel by an *embolus* or fragment of fibrin derived from a thrombus.

Fragments of tissue, tumors, particles of fat, air-bubbles, and microorganisms may also act as emboli.

The sequels depend on the kind of artery affected. Embolism of a terminal artery gives rise to anemic or hemorrhagic *infarct;* embolism of a large artery may lead to *gangrene* of the part supplied; if the blood-supply to the motor area of the brain is obstructed, *paralysis* results; if the embolus is infected, a *metastatic abscess* develops at the site of lodgment.

(a) What is a thrombus? (b) What is thrombosis? (c) Describe the three changes that may take place in a thrombus.

(a) A coagulum or clot in a blood-vessel remaining at the site of its formation.

(b) Thrombosis is the coagulation of the blood within the vessels or heart during life.

(c) *Organization*—new connective tissue grows into the thrombus from the walls of the blood-vessel. *Calcification—Liquefaction*—the formation of a reddish, puriform fluid in the interior of the thrombus. *Infection*—the thrombus may become infected by bacteria and suppurate.

What is thrombosis? Describe the manner of its formation.

The coagulation of blood within the blood-vessels or heart during life.

The *causes* are some disturbance which impairs the vitality of the endothelium, either in the vessel-walls or in the blood, and retardation of the blood-stream. The blood-platelets or plaques first adhere to the vessel-wall and form the nucleus for the clot. Leukocytes are deposited on and around this nucleus, break down, and liberate fibrin-ferment and permit the formation of *fibrin.* Red corpuscles are also entangled in the coagulating mass and give the red color to the thrombus.

Mention the difference between an embolus and a thrombus.

An embolus is a particle of fibrin which separates from a thrombus and lodges in some part of the circulation. A thrombus is a clot forming within a vessel, and is stationary.

Where are emboli most frequently found? Of what are emboli most frequently made?

In the lungs and brain. Emboli most frequently consist of fibrin derived from a thrombus.

Define infarction, and name the organs in which infarction most frequently occurs.

An infarct is a wedge-shaped infiltration of blood within an organ, due to obstruction, usually by an embolus or thrombus, of the artery supplying the area affected. Infarcts are most common in the lung, kidney, brain, and spleen.

Give the causes of hemorrhage.

1. Direct injury from without—*traumatic hemorrhage.*
2. Causes residing within the body—*essential, autogenous hemorrhage.*

(a) Increased blood pressure—whooping-cough (conjunctival hemor-

rhage, hemoptysis, cirrhosis of liver (esophagus, stomach, intestines, hemorrhoids); mitral stenosis (epistaxis, hemoptysis).

(b) Diseases of vessel-walls—atheroma and aneurysm; arteritis and phlebitis; infectious diseases (yellow fever, hemorrhagic small-pox).

(c) Change in the composition of the blood—anemia, hemophilia, embolism of an artery causing hemorrhagic infarction.

(d) Nervous disturbances—hysteria (bleeding from the hands and feet); in apoplexy, hemoptysis and hematemesis have been observed.

What is meant by hemorrhage by diapedesis? In what conditions does it occur?

Gradual escape of the blood through the walls of a blood-vessel without rupture. It occurs in conditions associated with disease of the blood-vessels, such as poisoning, various infectious diseases, hemophilia, scurvy, and the like.

INFLAMMATION

Explain the difference between congestion and inflammation.

Congestion is an excess of blood in a part, either *active*, due to causes enumerated above, or *passive*, due to venous *obstruction*.

Inflammation is a complicated process consisting in overfilling of the blood-vessels (hyperemia), the exudation of serum, the escape of leukocytes through the altered vessel-walls, and the proliferation of connective-tissue cells. It is the reaction of the tissue to an irritant. Active hyperemia is the first stage of inflammation.

What are the four cardinal indications of inflammation?

Redness, swelling, pain, and heat.

(a) Describe, in their order, and explain the cardinal signs of inflammation and (b) state the terminations of inflammation.

(a) *Redness*, due to overfilling of the blood-vessels. *Swelling*, explained by engorgement of the vessels and the escape of plasma and blood-corpuscles through the vessel-walls. *Pain*, due to pressure by the swollen tissues on the nerve-endings or the action of irritant products (bacterial). *Heat*, probably from increased heat-production due to active chemical changes.

(b) Resolution, regeneration or suppuration, necrosis, or some form of degeneration.

What histologic changes occur in acute simple inflammation?

1. Momentary contraction of capillaries, followed by dilatation. 2. Formation of new capillaries and contraction of the cells between the capillaries. 3. Retardation or even stasis of the blood-current. 4. Peripheral drift of the leukocytes. 5. Exudation of modified plasma and emigration of leukocytes, and sometimes diapedesis of red blood-cells, through the altered vessel-walls. 6. Swelling of the tissues—inflammatory edema. 7. Proliferation of connective-tissue cells and probably of leukocytes; or degenerative changes in these cells.

Describe catarrhal inflammation.

Inflammation of mucous membranes. The mucosa and submucosa are congested and edematous; there is an abundant serous, mucous, or muco-purulent exudate containing emigrated leukocytes and desquamated and degenerated epithelial cells. When the desquamation is very active, the process is suppurative or purulent (nasal catarrh). Erosions and hemorrhages are often present.

What is infective inflammation? How does it differ from simple inflammation?

Inflammation resulting from invasion of the tissues by bacteria, usually staphylococci or streptococci. It is more severe than simple inflammation and usually ends in suppuration or gangrene.

What is suppurative inflammation?

Inflammation characterized by an abundance of leukocytes in the exudate and usually of bacterial etiology. Fibrin formation is prevented, probably by the bacteria or their products, and the exudate undergoes liquefaction necrosis, forming pus.

What is the pathology of plastic inflammation?

The exudate contains fibrinogen and the fibrin-ferment is supplied by broken-down leukocytes. *Fibrin* is rapidly formed and causes adhesion between adjacent structures (layers of the pleura or pericardium). The fibrin later becomes organized and permanent adhesions, with obliteration of serous cavities, result.

What is productive inflammation?

In productive or chronic inflammation the proliferative changes predominate and new connective tissue is formed. Mucous surfaces become thickened, granular (granular pharyngitis), or polypoid (gastric and intestinal mucous membrane). It is also called *interstitial* when occurring in the substance of organs (interstitial nephritis).

Illustrate and define hypostatic inflammation.

Inflammation developing as the result of irritants acting on tissue the seat of hypostatic congestion. *Hypostatic pneumonia* occurs as a terminal infection in typhoid and other adynamic fevers and always involves the dependent portions of the lungs. Particles of food or secretions are aspirated and act as irritants to the parts already the seat of hypostatic congestion.

Describe 'termination of inflammation by resolution.'

The emigrated plasma and leukocytes reënter the blood-current or are carried off by the lymphatics. The cells, if they are numerous, first undergo softening and are absorbed in the form of an emulsion. The proliferated connective-tissue cells remain *in situ* or become wandering cells. Phagocytes also take part in the removal of broken-down cells. The tissue returns to its normal condition.

Describe healing by granulation.

The first stage comprises the usual changes incident to inflammation—dilatation of capillaries, exudation of serum, and emigration of leukocytes. The injured connective-tissue cells die and are disposed of by absorption and phagocytosis. On the second or third day there appear on the wound surfaces small red nodules called *granulations*, containing newly formed capillary sprouts, surrounded by proliferated connective-tissue cells—round-cells. This granulation tissue in a healthy wound is covered with pus—*laudable pus.* The capillary processes unite with similar processes from an adjacent or the same capillary to form new blood-vessels. The newly formed connective-tissue cells or round-cells around the capillaries elongate and form new fibrous tissue which afterward contracts and forms the *scar* or *cicatrix.* The epithelial continuity is restored by multiplication of the epithelial cells at the edges of the wound and the healing process is completed.

What is the composition of the inflammatory exudates?

A highly albuminous fluid with a high specific gravity—1015 to 1030—and alkaline reaction, containing leukocytes, red blood-cells, and a few endothelial (mesothelial) cells.

Discuss the effects of an exudative type of inflammation upon structure, and explain how and why function may be permanently impaired.

In fibrinous pleurisy the two layers of the pleura may become adherent and complete obliteration of the sac result; or the inflammation may terminate in suppuration—empyema—with the same result as regards function.

Explain the development of pus-corpuscles.

They are leukocytes, chiefly of the polynuclear type, contained in purulent exudates, and, as in inflammation generally, are the leukocytes that have passed through the walls of the capillaries.

Define phlegmon, abscess, ulcer, fistula, furuncle, carbuncle, caries.

Abscess: a circumscribed collection of pus in the substance of a part or organ. *Phlegmon:* diffuse purulent infiltration of a tissue. *Ulcer:* localized suppuration on a free surface with tissue destruction. *Fistula:* a suppurating canal connecting a body cavity or hollow organ with another cavity or the free surface of the body. *Furuncle:* a localized suppurative and necrotic inflammation starting in a hair-follicle, sebaceous gland, or sweat-gland. *Carbuncle:* a more extensive but similar process with multiple lesions and necrosis or gangrene of the skin and subcutaneous tissue. *Caries:* molecular destruction of bone (or teeth) corresponding to ulceration in soft tissues.

Describe the formation of an acute abscess.

Pyogenic micro-organisms invade the tissues through a solution of continuity in the skin or an organ by way of the lymph-channels and inaugurate

the phenomena of inflammation and suppuration. The collection of pus is localized and separated from the healthy tissue by a line of demarcation called *pyogenic membrane.* This may be the seat of liquefaction necrosis when the suppuration is spreading, or of regeneration when the connective-tissue (round) cells are in excess. The abscess continues to spread until it reaches the surface, a process termed *pointing*, rupture takes place, the pus is evacuated, and the resulting cavity heals by granulation.

Give your idea of the processes concerned in the formation of an abscess, say, a stitch abscess.

See previous question.

The micro-organisms in this case effect an entrance through the puncture made by the surgeon's needle.

Describe the formation of a metastatic abscess.

When an embolus is lodged in a terminal artery, the part supplied by this vessel is deprived of its circulation and becomes anemic, or occasionally a backward flow of blood takes place from the vein into the emptied vessels and a congestion occurs. If the embolus is an infected one, a metastatic abscess results.

Describe the process of ulceration.

Suppurative inflammation with destruction of tissue, occurring on free surfaces—the skin or mucous membranes. The floor of the ulcer is covered with granulation tissue and pus, and corresponds to the 'pyogenic membrane' of an abscess.

Varieties of ulcer are: *phagedenic*, spreading ulcers with rapid destruction of tissue; *serpiginous*, extending in one direction while other parts are healing; *indolent*, dry ulcers with scanty granulations and small tendency to heal; *round* or *peptic ulcer* of the stomach, due to digestion of the wall by the gastric juice; *pressure ulcers* (decubitus) and *perforating ulcer of the foot*, in which the process is necrotic.

Define gangrene.

The putrefaction of dead tissues still attached to the living body.

Briefly describe the types of gangrene, and give the conditions determining each.

Dry gangrene. The tissues are dark, friable, horny, and mummified, and separated from the healthy tissue by a *line of demarcation.* This form is due to arterial obstruction and evaporation of the tissue-juices. It occurs in old age (*senile gangrene*) from arteriosclerosis; in Raynaud's disease or '*symmetric gangrene,*' a nervous affection characterized by spasm of the arteries; in *frost-bite* and *ergotism*, from extreme contraction of the blood-vessels.

Moist gangrene. The affected part is swollen, soft, and pultaceous; the fluids are in excess; the color ranges from dark green to black as the blood pigment breaks down; the surface is covered with blebs and blisters; crepitation can be elicited (gas); the odor is characteristic. In moist gangrene the venous circulation is obstructed; it occurs in severe microbic infections (*hospital gangrene*); traumatism and severe inflammations

destroying the blood-vessels or obstructing the veins; diabetes; nervous (trophic) disturbances (certain bed-sores).

What is the line of separation in gangrene?

The line of ulceration and liquefaction between the line of demarcation and the dead tissue.

LYMPH-GLANDS

Give the causes and pathologic anatomy of lymphadenitis.

The causes are bacterial, usually the *pyogenic cocci*, *Bacillus tuberculosis*, or *Bacillus pestis*. The enlarged lymph-glands are congested, and may break down and suppurate; or the condition may end in resolution.

What inflammatory conditions may result in enlargement of the lymphatic glands?

Infected and suppurating wounds; gonorrheal urethritis, syphilis and chancroid, bubonic plague (inguinal glands); diphtheritic, scarlatinal inflammation of the throat (cervical glands); erysipelas; tuberculosis; actinomycosis.

What non-inflammatory condition may produce enlargement of lymph-gland?

Lymphadenoma and lymphosarcoma; sarcoma and carcinoma; leukemia and Hodgkin's disease.

BONES AND JOINTS

Give a minute description of and explain the process occurring in necrosis of bone.

Necrosis is death of a large or small portion of bone in mass and is due to interruption of the blood-supply. This may occur in periostitis, osteitis or osteomyelitis, or embolism. The dead fragment, called *sequestrum*, is irregular in outline and more or less eroded, and separated from the healthy bone by the process of demarcation, as in necrosis of soft parts—absorption of calcareous matter and proliferation of bone-cells. The sequestrum, like any foreign body, causes *suppuration* of the surrounding tissues. *Fistulæ* are usually present. A peripheral sequestrum may be discharged, and the loss may be made good by proliferation of the periosteal cells. If the sequestrum is central, discharge is impossible, and the sequestrum becomes surrounded with hyperplastic material, causing thickening of the bone.

Give the pathologic condition characteristic of necrosis and caries of bone.

Tuberculous osteitis.

What pathologic changes occur in caries?

Caseous degeneration and formation of *granulation tissue*, followed by softening and the production of a semifluid, cheesy material containing particles of bone. An abscess with a pyogenic membrane covering the walls of the cavity may result. The carious focus or abscess may become encapsulated by the formation of granulation tissue and cicatrization or new formation of bone.

How is dental caries produced?

Micro-organisms acting on starchy substances in the mouth produce lactic acid, which softens the enamel and permits the entrance of other bacteria—saprophytes, bacilli, and micrococci—into the dentine, with the production of caries.

Differentiate between caries and necrosis, giving etiology and pathologic anatomy of the later.

Necrosis is the death *en masse* of a large number of cells in the midst of living tissue. Caries is the *molecular* destruction of cells, especially bone-cells, and corresponds to ulceration in soft tissues.

Causes: Diseases of the periosteum, marrow, and bone, causing interruption of the blood-supply; embolism.

Pathologic anatomy: In necrosis the dead portion of bone or *sequestrum* (*sphacelus* in the case of soft tissues) is separated from the healthy bone by a process of separation. At the line of demarcation absorption of calcareous matter and proliferation of cellular elements take place. Fistulæ are usually present. The sequestrum may be discharged or encapsulated. The diseased tissue in caries undergoes gradual softening and caseation, with the production of a semifluid material containing particles of bone or calcareous matter. The process is seen in its typical form in tuberculosis of bone.

Give the pathology of spina bifida.

The posterior processes of the vertebræ fail to close and the membranes of the spinal cord protrude through the cleft in the form of a hernial sac. The hernia may be covered with skin or only with pia.

Describe the reparative process following the fracture of a long bone.

The successive phases are hemorrhagic extravasation in the marrow and at the line of fracture; congestion and cellular infiltration of the periosteum, marrow, and bone; formation of new blood-vessels and proliferation of cells; deposition of calcium and formation of bone and cartilage. The newly formed bone is called *callus ;* the outer portion is derived from the periosteum and is called the *periosteal* or *ring callus*, and the central portion —*pin-callus* or *myelogenous callus*—from the marrow. After absorption of the excessive callus is completed, some thickening persists at the seat of fracture.

What changes characterize inflammation of bone?

1. *Suppurative inflammation*—softening of the bone by absorption of the calcium salts and formation of granulation tissue by proliferation of the cells in the marrow and in the Haversian canals (*rarefying osteitis*). Localized abscesses or purulent infiltration with necrosis result.

2. *Hypertrophic inflammation*—deposition of bony tissue, as in normal bone-formation, and increase in density of the bone (*condensing osteitis*).

3. *Degenerative inflammation*—absorption of the calcium salts and increased porosity of the bone (*inflammatory osteoporosis*); formation of cavities containing bone-corpuscles (*osteoblasts*) and giant-cells—so-called Howship's lacunæ; increased vascularity and perforation by newly formed blood-vessels, establishing communications between neighboring lacunæ.

Describe and give locations in spina ventosa.

A form of rarefying osteitis in which the bone is thinned, giving forth a crackling sound on pressure, and finally destroyed; the bone tissue contains small cells with transuded red blood-corpuscles. Spina ventosa results from central or interstitial sarcoma and sometimes from syphilis; it occurs in flat bones and the articular extremities of long bones.

Mention the characteristic bone changes in rachitis.

Proliferation of the cellular elements and absence of normal calcification. The head is large and square, and union of the fontanels is delayed. The ends of the ribs at the junction with the costal cartilages are enlarged ('rachitic rosary'), as are also the ends of the long bones.

What is osteomalacia?

A constitutional disease characterized by absorption of the mineral constituents of the bones and increased flexibility, and a variable degree of cachexia. It is endemic in certain regions and occurs quite frequently during the puerperium. It is regarded by some authorities as a trophoneurosis.

Describe the changes that occur in cartilage in arthritis deformans.

At first softening and ulceration or erosion, producing a roughness of the surface; later the cartilage is gradually absorbed and the ends of the bones are exposed.

Describe the structural changes that occur in tuberculous joints.

The synovial membrane becomes thickened and edematous and sometimes ulcerates; the joint cavity becomes filled with a serous exudate; the joint and synovial membrane are invaded by the tubercles, and the synovial membrane now becomes shiny, smooth, and nodular. Fringes of the synovial membrane spread over the borders of the articular cartilage and become adherent to it; the cartilage becomes eroded and destroyed, and pieces of it become detached, leaving the bone denuded. The bone now is attacked by the tuberculous process. There may be adhesions, subluxation, erosion of the socket, or other joint deformity.

Describe the pathologic changes in hip-joint disease.

The joint cavity is filled with soft, spongy granulations and tubercles, which soon undergo suppuration or caseous necrosis. The soft tissues are inflamed and edematous, and later ulcerate or become necrotic. A cold abscess may form and burrow to the exterior. Ankylosis ultimately results from the formation of fibrous adhesions.

Describe the pathologic conditions produced by Pott's disease.

The affected vertebræ are replaced by granulation tissue and the intervertebral disks are absorbed. In favorable cases the tuberculous process is arrested at this stage, fibrous tissue replaces the granulations, and ankylosis with little deformity or functional disability results. In severe cases

the process of caseation goes on until the vertebræ are completely destroyed or converted into a sequestrum lying in a caseous abscess. The pus later finds its way toward the surface and a spinal abscess results. Finally, the vertebræ above and below the seat of the disease approach one another, and a prominence, known as an 'angular curvature' (kyphosis) is formed. This deformity is permanent and is associated usually with a compensatory lordosis in the lumbo-dorsal region.

TUMORS

What is understood by the phrase 'new formation'?

The apparently causeless formation of a mass of tissue in some portion of the body that does not subserve any useful purpose.

Give Cohnheim's theory regarding the cause of tumor formation. (b) Define sarcoma and carcinoma and give the usual method of metastatic extension of each.

(a) According to the *embryonal* or *evolutional* theory (Cohnheim) portions of tissue become misplaced during embryonal life and afterward take on active growth and develop into tumors.

(b) *Sarcoma*, a connective-tissue tumor in which the cells predominate so that the intercellular substance is quite insignificant.

Carcinoma: A historically atypical tumor, composed of epithelial proliferations and a well-developed connective-tissue stroma.

Metastasis takes place through the blood-vessels in sarcoma; carcinoma extends by—(1) infiltration of the surrounding tissues; (2) by metastasis along the lymphatics, and sometimes (3) through the blood-vessels (portal circulation).

(a) On what principle are tumors classified? (b) Mention the important classes of tumors, giving an example under each class.

(a) According to the tissue which is the prototype of the cells that compose the tumor.

(b) 1. Parablastomata, or connective-tissue tumors. *Examples:* fibroma (adult type), sarcoma (embryonal type).

2. Archiblastomata, or tumors after the type of specialized tissue. *Examples:* epithelioma, adenoma, papilloma, endothelioma, myoma, neuroma.

3. Teratomata, or mixed tumors. *Example:* dermoid cyst.

(a) Define and illustrate the term physiologic prototype as applied to tumors. (b) As a rule, what are the respective ages of occurrence of carcinoma and sarcoma? (c) Give the prognosis in a case of small, round-celled sarcoma in a child.

(a) The physiologic prototype of a tumor is the type of normal cell to which the cells of the tumor conform. *Example:* a sarcoma is a connective-tissue tumor, *i. e.*, a tumor the cells of which are connective-tissue cells.

(b) Carcinoma occurs in middle and advanced life (over forty years of age), sarcoma in children and young adults (up to forty years).

(c) Practically fatal.

The etiology of tumors—(a) What influence has age especially as to the connective-tissue type? (b) Sex, if a significant factor, denotes a predisposition to what? (c) What is the significance of heredity? Of local causes?

(a) *Age.*—Connective-tissue tumors are most common in early life, when the connective tissues grow most vigorously.

(b) *Sex* has little bearing on the etiology of tumors, except in the case of cancer, which is more common in females.

(c) *Heredity* is considered by some to be an etiologic factor; but the more probable view is that the *predisposition* to tumors and the *weakened resistance of the tissues* are hereditary.

Local predisposing factors: Irritation is held to be an exciting cause (cancer of the lip in smokers; cancer of the cervix developing in an old laceration).

Define the term malignant as applied to new formations.

New formations that recur after removal, give rise to metastasis, and ultimately produce death are called malignant.

Mention the malignant neoplasms.

Carcinoma, sarcoma, endothelioma, malignant adenoma.

What is a sarcomatous tumor? Give its pathology.

A sarcomatous tumor is one arising from connective tissue, with excessive cell formation and very little intercellular substance. The cells are either embryonic or imperfectly developed connective-tissue cells. Sarcomata are always mesoblastic in origin; their blood-supply is abundant, and it is through this channel that they are disseminated; of their lymphatics and nerve supply nothing is known. In gross appearance sarcomata are of a more or less homogeneous nature, the color depending upon the quantity of blood present; occasionally a milky fluid can be expressed, but there is never anything corresponding to the 'cancer-juice' of carcinomata. Sarcomata may undergo various secondary changes, such as fatty degeneration, hemorrhages, and mucoid softening. Sarcomata are malignant, hence they have a tendency to spread to distant organs (metastasis), are heterologous, have no definite limiting capsule, tend to infiltrate the surrounding tissues, tend to recur after removal, and cause cachexia and death. They have been classified in a variety of ways: (1) according to the *cells*, as round-cell sarcoma, spindle-cell sarcoma, giant-cell sarcoma, mixed-cell sarcoma; (2) according to the *stroma*, as fibrosarcoma, myxosarcoma, chondrosarcoma, osteosarcoma; and (3) according to *secondary changes*, as melanosarcoma, liposarcoma, chloroma.

Give a brief description of round-cell sarcoma.

There are three varieties:

(1) *Small round-cell sarcoma*, a soft, rapidly growing tumor, resembling brain substance. The cut surface is translucent and pinkish-white and exudes a milky fluid. It grows larger than any other form. Microscopically the tumor is made up almost exclusively of small round-cells with very little stroma.

(2) *Lymphosarcoma* characterized by the presence of intercellular substance arranged in a delicate reticulum resembling that of lymphatic glands. The tumor recurs, gives rise to metastasis, and is very malignant.

(3) Large round-cell sarcoma resembles the small round-cell variety, but the consistency is more firm. Some spindle-cells and multinuclear cells are also present.

How does sarcoma differ histologically from cancer?

Sarcoma is made up of embryonal connective-tissue cells with little intercellular substance; the blood-vessels are also embryonal and imperfectly formed, without distinct walls. *Cancer* is composed of epithelial cells arranged in plugs or acini, without intercellular substances, and surrounded by connective-tissue stroma containing well-developed blood-vessels.

Describe and give locations of melanosarcomata.

A sarcoma containing granules of melanin in the cells and intercellular substance, usually of the spindle-cell variety. Melanosarcomata are very malignant and occur in the choroid, the skin, and the meninges.

What are endotheliomata?

Sarcomata originating in the endothelium of lymphatics and blood-vessels.

(a) How is fibrous tissue formed? (b) What tumors are composed largely of fibrous tissue, and in what part of the body do they usually occur?

(a) By proliferation of the cells of the preëxisting, adjacent fibrous tissue and of leukocytes. The nutrition of the young cells, or fibroblasts, is maintained by capillaries which spring from the preëxisting vessels.

(b) Fibromata and fibromyomata, or 'uterine fibroids,' which occur chiefly in the uterus.

Define fibromata. Give the histology of fibromata.

A benign tumor of slow growth consisting of fibrous tissue. The fibrous tissue is poor in cells and consists chiefly of dense intercellular substance with few blood-vessels.

Describe in detail the pathology of uterine fibroids.

Rounded, circumscribed tumors consisting of smooth muscle-fibers and fibrous tissue, arranged in bundles or layers. They are hard, and on section present concentric or irregular lamellæ. Calcification and cystic change, due ot softening or to distention of the lymphatics, often take place. According to their relation to the uterus three varieties are described: (1) *submucous;* (2) *interstitial* or mural; and (3) *subperitoneal.* The first and third varieties may be pedunculated.

Fibroids are pathologically benign, but practically require operation on account of the pressure they exert, their interference with labor, and the metrorrhagia and endometritis to which they give rise. Submucous fibroids are sometimes expelled spontaneously from the uterus, and subperitoneal tumors may become free bodies in the abdominal cavity.

Give the varieties, the histology, and the physical characteristics of lipomata.

Sessile, and pedunculated or pendulous.

The lobules of fat are larger than in normal fat, and the connective-tissue trabeculæ are well developed.

Rounded, lobulated, encapsulated tumors that can be peeled out. The consistency varies with the proportion of connective tissue.

(a) Myoma—definition and histologic description of. (b) What determines the benign or malignant nature of a new-growth?

(a) A tumor composed of smooth muscle-fibers—liomyoma, or striated muscle—rhabdomyoma.

(b) *Benign.*	*Malignant.*
Do not disturb the general health.	Profoundly affect the general health.
No tendency to recurrence.	Recur after removal.
No metastasis.	Give rise to metastasis.
Remain within the tissue in which they originate.	Break through the limits of the parent tissue and invade the surrounding structures.

Define (a) neuroma. (b) Angioma.

(a) *True neuroma* is a tumor composed of nerve-fibers, either medullated (myelinic neuroma) or non-medullated (amyelinic neuroma).

False neuroma is a fibrous growth originating in nerve-sheaths.

(b) A tumor-like formation composed principally of blood-vessels.

Give the pathology of carcinoma.

A malignant tumor consisting of plugs or nests (acini) of proliferated epithelial cells contained in a stroma of connective tissue. It is not circumscribed and has a marked tendency to invade neighboring tissues.

Describe the pathologic histology of epithelioma and carcinoma.

The term *epithelioma* is usually employed to signify squamous carcinoma.

Histology: The epithelial cells are arranged in solid plugs embedded in the connective-tissue stroma. Near the periphery the cells are cuboidal, at the center flat and arranged in whorls, called *pearly bodies*.

Carcinoma (either cylindric or glandular cancer may be meant.): In cylindric cancer or epithelioma columnar cells or goblet cells are found near the periphery of the cancer nests; in the glandular form the cells are polyhedral.

Describe the macroscopic and the microscopic appearance of carcinoma of the breast.

In the early stage the skin is thickened, adherent, and stippled, the nipple is retracted, the gland feels hard in places. The axillary glands are enlarged. If the process is allowed to go on, ulceration develops.

The varieties are the medullary, simple, scirrhous, and myxomatous. Medullary or soft cancer consists almost entirely of epithelial cells and

contains an abundance of 'cancer juice'; in the scirrhous form bundles of connective-tissue inclosing collections of cancer cells are the prominent features; simple carcinoma occupies an intermediate position as regards the proportion of epithelial cells and fibrous tissue.

Give the gross and the microscopic appearance of an epithelioma of the lip.

An irregular, nodular elevation with ulcerated surface and infiltrated base. The microscopic appearance is that of squamous cancer (p. 579).

Give the various types of sarcoma and carcinoma, and name the sarcomata in the order of their malignancy.

Carcinoma: (a) squamous; (b) cylindric; (c) glandular. Clinically, the following varieties are distinguished: (a) hard or scirrhous; (b) soft, encephaloid, or medullary; (c) colloid. Rarer types are: c. myxomatodes, giant-cell c., melanocarcinoma.

Sarcoma: Melanosarcoma, round-cell sarcoma (see p. 577), giant-cells., alveolar s., spindle-cell s., endothelioma, chloroma, psammoma, in the order of their malignancy.

Give the histologic characteristics of adenoma.

Adenoma originates from preëxisting glandular tissue, either from the acini or from the tubular portions of the gland. The acini are lined with spheroidal epithelium, intercommunicating by ducts. The tubular form consists of tubules with cylindric epithelium and originates in mucous membranes.

Give the origin and appearance of papillomata.

Papillomata originate from the papillæ of the skin and from mucous membranes. They are wart like, branching or polypoid, sometimes cauliflower-like masses covered with epithelium.

Enumerate in order of frequency the tumors of the parotid gland.

Mixed tumors, sometimes called fibro-chondro-myxo-sarcoma are the most common; fibroma, lipoma, chondroma, epithelioma—all of which are rare.

What pathologic changes may cicatrices undergo?

Carcinomatous, keloid, ulceration, and abscess formation.

What are cysts? How are cysts formed? Give the varieties of cysts.

The varieties of cysts are:

I. *Non-tumorous:*

(a) Extravasation cysts, resulting from hemorrhage, followed by absorption of the blood-pigment and encapsulation.

(b) Softening cysts, from circulatory disturbance, liquefaction necrosis, and encapsulation.

(c) Parasitic cysts, as echinococcus or hydatid cyst.

II. *Neoplastic cysts:*

(a) Retention cysts, resulting from obstruction and distention of gland-ducts (follicular, mucoid, congenital).

(b) Dermoid or teratoid cysts. These develop from misplaced embryonal rests.

(c) Proliferation cysts or cystadenomata, formed by the proliferation of the epithelial cells of gland-acini and secretion of the cells. They are usually multiple.

Describe a retention cyst.

A cystic tumor resulting from obstruction of a gland-duct, followed by distention and accumulation of the secretion. The epithelium lining the cyst is the same as that of the gland.

Give pathology of cystic ovary.

Simple follicular cysts result from distention of the Graafian follicles. The cavities are lined with epithelium and the contents are serous or blood-tinged. The cyst may be unilocular or multilocular. The organ is considerably enlarged.

What are teratomata?

Tumors containing elements of different tissues in a situation where they do not occur normally. They result from misplacements or inclusions of tissue during embryonal life, are mostly cystic (dermoid cyst), and contain various *epidermal structures,* such as hair, teeth, sweat-glands, and the like.

INFECTIONS

What is the pathology of erysipelas?

A severe inflammation of the skin and subcutaneous tissues due to infection by *Streptococcus erysipelatis,* accompanied by the formation of blebs, and usually ending in resolution, but sometimes in general septicemia and death.

In uncomplicated cases inflammatory edema and sometimes suppuration are found postmortem. The cocci are found in the lymph-spaces. Infarcts occur in the lungs, spleen, and kidneys; malignant endocarditis and septic pericarditis and pleuritis may develop in erysipelas. The meninges are rarely involved. The kidneys show acute nephritis.

Describe the rash and give the morbid anatomy of scarlatina.

A fine, punctate, scarlet rash, appearing first on the neck, chest, and flexures of the joints and rapidly spreading to the entire body. The redness usually disappears on pressure.

Acute pharyngitis and tonsillitis; enlargement and sometimes suppuration of the submaxillary and cervical glands; catarrhal inflammation of the gastro-intestinal tract; engorgement of the liver and spleen; granular degeneration of the muscles; and hemorrhagic nephritis, especially involving the glomeruli. There are no specific lesions.

Mention some lesions peculiar to scarlet fever.

Acute parenchymatous nephritis, arthritis, simple and malignant endocarditis, otitis media, adenitis (of the submaxillary glands), symmetric gangrene, and noma.

Give the pathology of nephritis following scarlatina.

See acute parenchymatous nephritis, p. 599.

What are the characteristic features of diphtheritic exudation or infiltration of mucous membrane?

The formation of a grayish membrane of varying thickness, firmly adherent, and sometimes extending deeply into the tissues; early failure of the nuclei to take the stain; the deposition of granular or fibrillar fibrin, or in the form of a homogeneous mass, in the cells and intercellular substance. The process is a *coagulation necrosis.*

Describe the microscopic appearance of a true diphtheritic membrane.

The exudate consists of a homogeneous, finely granular or fibrillar mass, surrounding and embedding the epithelial cells and containing leukocytes. The cells and connective tissue are the seat of *coagulation necrosis* and appear granular. The nuclei are affected very early, and fail to take the stain before the fibrin makes its appearance. Layers of round-cells are often present and produce stratification of the membrane. The blood-vessels are compressed or thrombotic, and the tissue is very poorly supplied with blood.

What is the special cause of the croupous inflammation found in diphtheria?

The toxin of the diphtheria bacillus.

What apparent differences in throat lesions in diphtheria and follicular tonsillitis?

The false membrane in *diphtheria* is grayish in color and covers the parts adjacent to the tonsils, as well as the glands themselves. Its removal requires some force and is followed by bleeding. In *follicular tonsillitis* the crypts are filled with a whitish, cheesy material, and the plugs can be removed without difficulty and without causing hemorrhage.

What constitutes the difference between laryngeal or true croup and spasmodic croup?

In the former the larynx is covered with the characteristic diphtheritic pseudomembrane; the latter is a purely nervous affection, occurring chiefly in rachitic children, without pathologic changes in the larynx, or at most a slight catarrhal laryngitis.

Mention some pathologic lesions that are sometimes the sequelæ of diphtheria.

Myocardial degeneration, nephritis, necrotic foci in the liver, degeneration of the peripheral nerves.

(a) Describe what you consider the most characteristic anatomic lesion of typhoid fever, and (b) give the chief avenues of elimination of the specific organisms from the body.

(a) The typhoid ulcer is the end stage of hyperplasia and necrosis of a Peyer's patch. The swelling is due to the accumulation of round-cells, which compresses the vessels and causes necrosis of the lymphoid elements. The ulcer has the shape of a Peyer's patch; its axis is usually longitudinal (parallel with the long axis of the gut). (b) In the feces and in the urine.

Give the lesions of typhoid fever.

Catarrhal inflammation of the ileum and beginning of colon; hyperplasia, round-cell infiltration, necrosis and ulceration of Peyer's patches and the solitary follicles (specific lesion); sometimes hemorrhage and perforation. For typhoid ulcer see **above.** The mesenteric lymph-glands and the spleen are enlarged.

Give the distribution of typhoid bacillus in the body during typhoid fever.

The intestinal lesions, feces, urine, spleen, mesenteric glands; occasionally the meninges and post-typhoidal abscesses.

Describe the lesions in perforation of the intestine in the course of typhoid fever.

The lesions are those that lead up to the formation of the ulcer (*q. v.*). Toward the end of the third week, as the necrotic tissue is thrown off, perforation of the bowel or of a blood-vessel may take place.

Is cerebrospinal fever more generally sporadic or endemic?

Sporadic.

What structures are principally involved in bubonic plague? How are these structures affected?

The lymphatic glands, lungs, skin, and mucous membranes, kidneys, spleen, and gastro-intestinal tract.

The inguinal glands are most often affected, then, in order, the axillary, cervical, and popliteal; enlargement ending in resolution or suppuration, and rarely gangrene occurs. The lungs may be the seat of a bronchopneumonia or a primary plague pneumonia. Petechiæ and carbuncles develop on the skin ('plague spots'), and hemorrhages from mucous membranes occur. The kidney lesion is an acute general nephritis; the spleen is enlarged (hyperplastic splenitis); the intestines are the seat of hemorrhagic gastro-enteritis.

What organs are most subject to tuberculosis?

1. Respiratory tract—lungs, bronchioles, and larynx. 2. Intestinal tract—ileum and rectum, mouth and pharynx, rarely the stomach. 3. Lymphatic glands. 4. Serous membranes—peritoneum, pleura, meninges, synovia. 5. Bones. 6. Spleen, kidney, and suprarenal bodies. 7. Brain. 8. Middle ear. 9. Bladder and testicles. 10. Skin. 11. Uterus and appendages.

Give the process of tubercle development.

Invasion by tubercle bacilli; irritation of fixed connective-tissue cells, resulting in production of round-cells, called *epithelioid cells*, some of which coalesce to form *giant-cells;* infiltration with leukocytes from surrounding blood-vessels—round-cell inflammation (*lymphoid cells*)—around the focus of irritation; the tubercle now appears as a gray, translucent body (*gray tubercle*). Hyaline degeneration, coagulation necrosis, fatty degeneration, and caseation resulting in the *yellow tubercle.* Encapsulation and calcification may occur.

Give the varieties of tubercle.

Miliary tubercle or gray nodule; yellow tubercle; lymphoid tubercle; epithelioid tubercle.

Describe yellow or crude tubercle.

A small nodule, 1 to 2 millimeters in diameter, drier and harder than the surrounding tissue, containing cheesy material in the center. Microscopically the tubercle is made up chiefly of *epithelioid cells*—large elements with vesicular nuclei—with one or several *giant-cells* in the central caseous area, and surrounded by a zone of round-cells—the so-called *lymphoid cells.*

What is a giant-cell? Give characteristics.

A large cell containing several nuclei, formed either by the fusing of several cells or by division of nuclei and increase in the cytoplasm, without further division of the body. They are leukocytes (phagocytes), connective-tissue, or endothelial cells; the nuclei may be three or four in number, or a score or more. Giant-cells occur in granulation tissue, bone-marrow, tubercles, gummata, and in giant-cell sarcoma.

By what methods would you recognize positively tuberculous lesions?

1. By demonstrating the characteristic cells of tuberculous inflammation —epithelioid, lymphoid, and giant-cells.
2. By demonstrating tubercle bacilli in the lesion.
3. By animal inoculation.

Describe the pathology of acute miliary tuberculosis.

A general infection of the body by way of the blood-channels, the source of infection in most cases being a preëxisting tuberculous focus in the lungs, lymph-glands, bones, or kidneys. The tubercles are small, of the gray miliary type, and scattered throughout the body, upon the pleura and peritoneum, in the lungs, liver, kidneys, lymph-glands, and spleen; on the meninges, in the bone-marrow, and sometimes in the choroid coat of the eye.

What pathologic changes are found in Addison's disease?

Tuberculosis of the suprarenal bodies; pigmentation of the skin.

Describe (a) the syphilitic lesions of the skin. (b) The lesions in lupus.

(a) The *secondary syphilids* are symmetric, polymorphous, run a definite course, involve the superficial parts of the skin, and leave little, if any,

scar. The lesions are erythematous, papular, and pustular. The *macular* syphilid, or syphilitic roseola, is circular, of a faint rose-red color, later changed to purple and yellowish red, and but little raised above the skin; it disappears on pressure. The *papular* syphilid consists of firm, fleshy red elevations from the size of a pin-head to one inch in diameter. Lenticular and miliary papular syphilids are described, according to the size of the lesions, the miliary being very rare. The *pustular* syphilid may develop primarily or from a macular or papular eruption. The lenticular (varioliform) and miliary (acneform) are differentiated. The former are small, hemispheric, pea-sized pustules with a hard base surrounded by an inflammatory areola. The miliary pustules range in size from a millet-seed to a pin-head and occur in groups. Both varieties are covered with crusts.

What are the possible lesions in the (a) second and (b) third stages of syphilis?

(a) Macular, papular, or ulcerative syphilids (general cutaneous eruptions); mucous patches and condyloma latum (on mucous membranes); glandular enlargements (buboes); iritis and falling out of the hair.

(b) Gummata, ulcers, localized skin lesions (tertiary syphilids, rupia, etc.), thickening of the arteries (due to hyperplasia of the intima), and sclerotic changes in the liver, kidneys, and central nervous system, especially the cord.

Describe a syphilitic gumma.

A round tumor, ranging in size from that of a pea to that of a small apple, raised above the surrounding surface, and of variable consistency, with a tendency to central softening. The center contains grayish or yellowish 'gummy' material, due to mucoid degeneration. The connective tissue is abundant and forms a capsule and radiating trabeculæ within the gumma. Microscopically, epithelioid and round-cells and giant-cells are seen, with thickening of the intima of the blood-vessels. Gummata on surfaces tend to ulcerate; within organs they usually undergo absorption.

HEART AND BLOOD-VESSELS

What pathologic lesions are present in pericarditis?

Four varieties of pericarditis are recognized:

(a) *Serous.*—The sac is filled with serum containing flakes of fibrin, some of which adhere to the pericardium.

(b) *Fibrinous.*—Abundance of fibrin with little serum; adhesions between the two layers are common. The fibrin is disposed in ridges or small, villous projections (cor villosum).

(c) *Serofibrinous.*—A combination of the two preceding forms.

(d) *Purulent.*—The pericardium is covered with pus and fibrin and the cavity contains a thick, purulent exudate.

Name the conditions that give rise to hypertrophy of the heart and explain how they act in so doing.

(1) Mechanical pressure from without—*tumors* or *adherent pericardium*. The hypertrophy is soon followed by atrophy.

(2) *Valvular lesions:* The hypertrophy is a compensatory process, the object being to overcome the increased resistance. Different chambers of the heart are affected, according to the seat and character of the valve lesion. It is greatest in aortic regurgitation and stenosis, and chiefly involves the left ventricle.

(3) *Arteriosclerosis and aneurysm:* The resistance to the propulsion of the blood is in the arterial system.

(4) *Circulatory disturbances in the lungs,* which may be due to congenital heart diseases, emphysema, fibroid phthisis, or other disease of the lungs.

Name the diseases in which cardiac hypertrophy commonly results, and explain why.

Chronic endocarditis and myocarditis, chronic interstitial nephritis, and arteriosclerosis.

In obstruction and regurgitation, whether valvular or muscular, hypertrophy is a conservative change and enables the heart to overcome the interference with its mechanism or to establish compensation. In chronic interstitial nephritis and arteriosclerosis the resistance offered by the contracted and rigid arteries necessitates hypertrophy to enable the heart to propel the blood through the arterial system.

What changes take place in hypertrophy of the heart?

The cavity is enlarged and the wall increased in thickness. Rarely the size of the cavity is unchanged (simple or pure hypertrophy) or even diminished (concentric hypertrophy). The ventricles are chiefly affected.

Describe the changes in the heart due to fatty metamorphosis.

The size is increased, the color is yellowish streaked, and the consistency is softer than normal. The surface on section exudes fat-droplets and the knife is oily. The fat is deposited in granules between the muscle-fibers and beneath the pericardium. Protoplasm and nucleus are displaced, but maintain their integrity. The process often terminates in fatty degeneration.

Give the etiology and pathologic nature of acute endocarditis. If the patient recovers, what permanent pathologic condition results?

Etiology: Acute articular polyarthritis (rheumatism), scarlet fever, pneumonia, puerperal sepsis. It is probably always due to the action of bacteria, chiefly staphylococci, streptococci, and pneumococci.

Pathologic anatomy: First, a line of roughness forms across the valve near the free edge, small nodular elevations, like beads, or distinct wart-like elevations make their appearance (verrucose or simple endocarditis); or ulcers may form (ulcerative or malignant endocarditis).

Results: Simple endocarditis heals by absorption of the fibrinous deposits on the valves and cicatrization, which produces more or less deformity, so that the valves fail to perform their function and chronic endocarditis results.

What valve is most commonly involved in endocarditis? What are the structural types of endocarditis and the common micro-organisms which produce these lesions?

The mitral. The varieties of endocarditis are: (a) *simple*, verrucose or warty; (b) *ulcerative* (malignant); (c) *sclerotic* or indurative. The common micro-organisms are *Staphylococcus pyogenes aureus* and *Streptococcus pyogenes*.

Describe how mitral stenosis and aortic regurgitation respectively affect the cavities and musculature of the heart.

Mitral stenosis: The left auricle becomes hypertrophied (marked accentuation of second pulmonic sound), pulmonary congestion ensues, the right ventricle, and later the right auricle, also hypertrophy. During the later stages the enlargement of the right side of the heart is most marked; jugular pulsation and congestion and pulsation of the liver may develop.

In *aortic regurgitation* the left ventricle is chiefly affected, becoming greatly hypertrophied—so-called *cor bovinum*. Enlargement of the right heart occurs late.

State the results of stenosis of the tricuspid valves of the heart.

Dilatation of right auricle, cyanosis of the face, jugular pulsation, passive hyperemia of pulmonary and abdominal organs, pulsation of liver, general anasarca.

Describe the spleen and kidneys from an individual dead after a long-standing mitral insufficiency.

The organs present the condition known as *cyanotic induration*, consisting in hyperplasia of the connective tissue, contraction and atrophy of the parenchyma, with pigmentation. The organs are small and intensely hard.

Explain why and how obstructive disease of the coronary arteries causes myocardial degeneration.

By interfering with the blood-supply of the heart muscle.

What pathologic changes may cause angina pectoris?

Arteriosclerosis of the coronary arteries; myocarditis; endocarditis, especially aortic regurgitation; adherent pericardium.

What are the degenerative changes of arteries?

Fatty, hyaline, calcareous, and amyloid degeneration.

Describe the pathologic conditions present in atheroma.

Atheroma is a stage in the process of arteriosclerosis characterized by fatty degeneration of the intima and media. The term is loosely employed as a synonym of arteriosclerosis (*q. v.*, p. 588).

To what diseases does calcareous degeneration of the arteries predispose?

Aneurysm; cerebral hemorrhage; infarct (cerebral); dry gangrene.

What general pathologic lesion characterizes chronic alcoholism?

Arteriosclerosis.

How does calcareous degeneration of the arteries influence the circulation?

The resistance due to the heightened blood-pressure increases the work of the heart and weakens the muscle; the arteries are brittle and predisposed to hemorrhage, especially in the brain.

Describe the autopsy findings, as regards the vascular and urinary systems, one would expect in a case of arteriosclerosis of long standing.

The intima of the arteries becomes thickened and at first translucent (*hyaline degeneration*), later firm, opaque, and yellowish white (*fatty degeneration*) and finally hard from infiltration with lime (*calcification*). The atheromatous patches may break down (liquefaction necrosis), discharging their contents into the lumen and leaving ulcers (*atheromatous ulcers*). The media and adventitia become more robust by the production of fibrous connective tissue, compensating in a measure for the loss of elasticity. Arteriosclerosis may be circumscribed (nodular) or diffuse. The various processes are usually seen at the same time in different portions of the vascular system. The veins are sometimes involved, especially in the portal system (phlebosclerosis or angiosclerosis). The *heart* is often greatly *hypertrophied*, but sometimes normal or even contracted, and the seat of brown induration. The *kidney* is small and hard from overgrowth and contraction of connective tissue; the color is dark red, the surface granular, and the capsule adherent. The blood-vessels, tubules, and glomeruli are sclerotic, thickened, and surrounded by round-cell infiltration. This condition is called contracted or *arteriosclerotic kidney*.

Describe the changes in the wall of an artery occurring in any form of aneurysm.

The earliest changes are due to atheroma and arteriosclerosis (*q. v.*). The blood-pressure being increased, the artery dilates at a point where it has been weakened by disease, and the wall undergoes compensatory thickening.

A *true* aneurysm is one consisting of all the coats of the vessel. A *false* aneurysm is one in which one or two of the coats are not represented; usually the wall consists of the adventita. In a *dissecting* aneurysm the blood, after rupture of the inner coats, separates the intima and adventitia for a certain distance and breaks through the inner coat into the vessel, or through the adventitia into the surrounding tissues.

Describe the pathologic changes occurring in acute phlebitis.

As the inflammation begins in the surrounding tissues, the outer coat of the vein is first involved. The adventitia is the seat of round-cell accumulation and suppuration. The process may extend to the media and intima, often resulting in thrombosis. The thrombi may become infected secondarily, give off septic emboli, and thus produce pyemia.

Give the sites and the pathology of varicose veins.

Dilatation of the veins occurs from mechanical obstruction to the circulation or from weakness of their walls. It is found more commonly in dependent portions of the body, and is particularly frequent in veins of the legs, rectum, esophagus, neck of the bladder, spermatic cord, scrotum, and vagina. The veins become dilated, tortuous, and elongated. The walls of the dilated veins are usually considerably thickened.

Give the pathologic features of angioleucitis (lymphangitis).

The walls of the lymphatics present the signs of inflammation, with edema and leukocytic infiltration, and the vessels are filled with serous or seropurulent fluid.

What are some of the results of lymphorrhagia?

Chylous extravasation, lymph fistulæ, chyluria, chylothorax, chylous ascites.

What conditions may result from enlargement of lymph-spaces or lymph-vessels?

The term *lymphangioma* is applied to a tumor composed of dilated lymph-vessels or lymph-spaces; it may be capillary, cavernous, or cystic. *Macroglossia* is an enlargement of the tongue; *macrocheilia*, of the cheeks; *congenital cystic hygroma* ('hydrocele of the neck'); *nævus lymphaticus*, of the skin; *elephantiasis*, of the legs and scrotum.

THE LUNGS AND BRONCHI

Give the morbid anatomy of chronic bronchitis.

Congestion and fibrous thickening of the bronchial mucous membrane; sometimes it is atrophied and thin. Mucus is present in variable quantities. Disappearance of ciliated columnar epithelium.

Describe and give the pathology of congenital atelectasis.

Congenital atelectasis, or failure of the lungs to expand after birth, is due to general weakness, compression of the thorax, cerebral hemorrhage, or obstruction of the bronchus. The bases are chiefly affected. The lungs are dark red and the cut surface is smooth. Crepitation is absent, and the tissue sinks in water.

Give the pathology of alveolar, interstitial, and atrophic forms of pulmonary emphysema.

Alveolar.—Dilatation of the air-vesicles. The emphysematous areas are pale and surrounded by congested lung tissue; when incised, they collapse.

Interstitial.—The air can be pushed about in the emphysematous area. It is not confined to the alveoli, but travels along the trabeculæ, the bronchi, or the fasciæ of the neck. These two forms are usually transitory.

Atrophic.—The lungs are enlarged and meet in front, covering the heart, the anterior borders of the upper lobes being chiefly affected. The emphysematous areas are pale; the blebs or bullæ vary in size according as they

represent one or several vesicles. The bronchi are also dilated. The characteristic changes are atrophy and slow fatty degeneration of the septa, which ultimately disappear.

Distinguish between fibrinous, catarrhal, purulent, and fibrous pneumonia.

Fibrinous, croupous, or *lobar pneumonia* is an inflammation of the air-vesicles, with proliferation of cells, exudation, and coagulation necrosis of the exudate, involving one or several lobes. Cause: Pneumococcus of Fränkel.

Catarrhal or *lobular pneumonia* is also characterized by cellular proliferation and an exudate containing red blood-cells and leukocytes, but the exudate does not undergo coagulation necrosis; the cut surface is moister than in croupous pneumonia. One or several lobules, rarely an entire lobe, are involved. Cause: Pneumococcus, usually in association with streptococcus or staphylococcus.

Purulent pneumonia, either in the form of a single, or multiple abscesses or a purulent catarrh. *Single* abscess usually follows lobar pneumonia; *multiple* abscesses are due to aspiration of infected material, embolism, or metastasis, or extension from suppuration in adjacent organs (mediastinum, pleura, bronchi, liver).

In *fibrous* or *interstitial pneumonia* permanent connective tissue is formed as a result of the cellular proliferation. It may be: (a) parenchymatous, due to the inhalation of irritants (pneumonokoniosis), congenital syphilis (white pneumonia), or a termination of lobar pneumonia. (b) Secondary, due to extension of fibroid pleurisy; syphilis, healing of gummata; tuberculosis, healing of tuberculous process.

What pathologic changes in lung tissue occur in the various stages of lobar pneumonitis?

1. Congestion of engorgement. 2. Solidification: (a) red hepatization, (b) gray hepatization. 3. Resolution. See next question.

Give the morbid anatomy of acute lobar pneumonia.

Lobar, croupous, or fibrinous pneumonia is an inflammation of the air-vesicles, with cellular proliferation, exudation, and coagulation necrosis of the exudate. The process is divided into three stages:

(1) *Stage of engorgement or congestion,* during which the capillaries of the intervesicular walls are distended and the vesicles filled with serous fluid (inflammatory edema) containing endothelial and red blood-cells.

(2) *Stage of Consolidation.*—The exudate undergoes coagulation necrosis and the air-vesicles contain fibrin, red blood-cells, and desquamated endothelial cells. The lung is solid, does not collapse when the thorax is opened, and sinks in water; the color is dark red; the lung tissue is friable. The surface of section is granular from the projection of plugs of fibrin (*red hepatization*). The color gradually changes from red to gray (*gray hepatization*) as the red cells are destroyed and absorbed, and the number of leukocytes increases. The lung is anemic from pressure of the exudate on the blood-vessels. The appearance of the cut surface resembles that of broken granite.

3. *Stage of Resolution.*—The exudate undergoes fatty degeneration and liquefaction, and is in part expectorated and in part absorbed. The cut surface is smooth and exudes a whitish fluid. The lung regains its normal color.

Describe in detail the pathogenesis of acute croupous or lobar pneumonia.

The pneumococcus or *Diplococcus pneumoniæ* (Fränkel-Weichselbaum) gains access to the lungs through the bronchi or exceptionally through the blood, and inaugurates the characteristic inflammatory changes. Predisposing causes, such as exposure to cold, traumatism, fatigue, or general weakness, probably render the lung tissue less resistant or increase the virulence of the diplococci which are normally present in the mouth.

Name the organism most frequently associated with acute lobar and bronchopneumonia.

Acute lobar—*Diplococcus pneumoniæ* (Fränkel-Weichselbaum). Bronchopneumonia—the same, in association with streptococci and staphylococci, the pneumobacillus of Friedländer, bacillus of influenza, Bacillus typhosus, and Bacillus coli communis.

How does croupous (lobar) pneumonia differ from catarrhal (lobular) pneumonia in the microscopic characteristics of the exudate?

In *lobar* pneumonia the serous exudate contains fibrin, some red blood-cells, and endothelial cells from the walls of the alveoli. The exudate undergoes coagulation necrosis.

In *catarrhal* pneumonia the exudate contains red and white corpuscles and epithelial cells, but little or no fibrin. There is no tendency to coagulation necrosis.

Describe a lung affected by bronchopneumonia.

The lung contains scattered areas of consolidation corresponding to individual lobules, which are usually pale and surrounded by congested lung tissue. The cut surface is smooth and moist, and on pressure exudes a frothy serum from the healthy portions and a grayish-yellow fluid from the diseased areas. The lobules, about as large as hazel-nuts, stand out prominently.

Describe the lung in a case of pneumonokoniosis—'miners' consumption.'

In a well-marked case the lung presents large areas of induration in which the vesicular structure of the organ is entirely destroyed. Fibrous bands accompany the bronchi and radiate in every direction toward the periphery. The fibrous tissue is sometimes arranged concentrically around a nucleus of coal-dust. The lung is contracted, the pleura is drawn inward and thickened. The dark color of the affected areas is due chiefly to the coal-dust, but partly also to hemorrhagic pigmentation.

Mention the usual pathologic progression in pulmonary tuberculosis.

Invasion by tubercle bacilli, inflammation, formation of tubercles, encapsulation, and recovery, or secondary infection with pyogenic bacteria, suppuration and cheesy degeneration of the tubercles, and cavity formation.

Describe in detail the process of cavity formation in a case of tuberculosis of the lungs.

Infection with *Bacillus tuberculosis* first gives rise to the production of tubercles, as explained on page 584. As the lesions break down and finally undergo coagulation and liquefaction necrosis or caseation, the lung tissue takes part in these changes, is destroyed, and a cavity results. The cavity may grow by continued softening and cheesy degeneration of the walls, or fibrous tissue may be formed, encapsulating the cavity and arresting the spread of the tuberculous process. Sometimes the contents of a cavity undergo calcification.

Give the pathology of the different forms of pleurisy.

Fibrinous.—Both surfaces of the pleura are covered with fibrin and yellow lymph, or there may be very little exudate (*dry pleurisy*). The pleura underneath is dry, opaque, and rough. Adhesions between the two layers and partial or complete obliteration of the sac are specially frequent in this form.

Serofibrinous.—Acute pleurisy. The exudate contains much fibrin and pale-yellow fluid that tends to coagulate. Flakes of lymph are found in the exudate.

Serous.—The effusion is abundant and contains very little fibrin. This form is frequently tuberculous.

Terminations of Pleurisy.—Absorption, with a few slight adhesions; extensive adhesions or obliteration of the sac; suppuration or empyema.

Empyema (Pyothorax).—The exudate is purulent. The condition is often tuberculous.

Give causes of hemothorax.

Perforating wounds, fracture of ribs, rupture of an aneurysm into the pleural sac.

ABDOMINAL ORGANS

What conditions may cause dropsical effusion in the abdomen and in the lower extremities?

1. Valvular heart disease and myocarditis. 2. Diseases of the liver, especially cirrhosis (portal obstruction); syphilitic hepatitis; tumor. 3. Diseases of the kidneys; ascites sometimes occurs as part of a general anasarca. 4. Tuberculous peritonitis. 5. Neoplasms so situated as to interfere with the portal circulation. 6. Cancerous and tuberculous cachexia.

Give the pathology of peritonitis.

The peritoneum is injected, lusterless, and covered with lymph. The exudate in the peritoneal cavity is at first serous and may become fibrinous or purulent. Peritonitis tends to become localized by the formation of adhesions in the peritoneal cavity.

Compare the pathologic histology of tuberculous and traumatic peritonitis.

In *traumatic peritonitis* the membrane is injected, lusterless, and covered with fibrin and lymph. A small amount of serous or fibrinous exudate is present and adhesions are usually formed.

Tuberculous peritonitis is characterized by the presence of tubercles, which coalesce to form large masses. There is an abundance of serous exudate, and extensive fibrinous or fibrous adhesions are formed. In advanced cases the peritoneum is thickened.

From what causes may stricture of the esophagus arise?

Cicatrization of ulcers caused by swallowing corrosive liquids (carbolic acid, lye); syphilis; carcinoma; rarely typhoid fever and tuberculosis.

[If the question is intended to include stenosis, pressure of a tumor or aneurysm on the esophagus, foreign bodies, and the presence of a tumor in the walls should be added.]

Describe the pathologic characteristics of gastric ulcer.

Peptic ulcers are usually multiple and situated in the lesser curvature and in the posterior wall of the stomach, near the pylorus. The size varies from a few millimeters to five centimeters; the shape is like a funnel with the apex in the muscular coat.

The scars that result from healing of an ulcer have a characteristic stellate form. If they are extensive, pyloric stenosis or hour-glass contraction of the stomach may result. Carcinoma not infrequently develops on the site of an old ulcer.

Carcinoma of stomach: (a) Is it usually primary or secondary to carcinoma elsewhere? (b) Where is it usually situated, and give most common type.

(a) Usually primary. (b) It is usually situated at or near the pylorus in the lesser curvature, and the most common type is the cylindric-celled adenocarcinoma.

What laboratory methods may be of service in the diagnosis of cancer of the stomach?

Analysis of the stomach-contents may show absence of hydrochloric acid and the presence of lactic acid and the Oppler-Boas bacillus. Occasionally pieces of tissue may be obtained for microscopic examination and may show cancer-cells.

Give the structural changes which take place in chronic and acute appendicitis.

Appendicitis is divided into—(1) catarrhal; (2) necrotic or gangrenous; (3) interstitial (chronic form).

In the *catarrhal* form there are slight swelling and congestion of the mucous membrane and retention of the contents of the appendix, which are mucopurulent in character.

In *gangrenous* appendicitis the mucosa is destroyed, local peritonitis with adhesions develops in the serous coat, walling off the disease focus. Rupture may take place early, with the production of general purulent peritonitis. If an abscess forms, the pus contains the remains of the dead appendix.

Interstitial appendicitis is characterized by the production of connective tissue and thickening of all the intestinal coats. It results in chronic thickening.

What are the anatomic lesions of acute dysentery?

Three varieties of dysentery are described:

1. *Catarrhal*—characterized by congestion, swelling and edema of the mucous membrane of the large intestine, with petechiæ and occasional ulcers.

2. *Ulcerative*—see Amebic Dysentery, next question.

3. *Diphtheritic*—the walls are covered with a grayish or brownish false membrane of varying thickness, sometimes destroying the muscularis and submucosa. The cells are necrotic and embedded in a fibrinous matrix (coagulation necrosis); masses of round-cells are present. The severest form is called *gangrenous dysentery*.

Give the gross pathology of amebic dysentery. Describe the organism giving rise to it and name the pathologic condition of the liver often associated with it.

The mucosa is swollen and covered with scattered ulcers having a ragged outline and undermined edges. The ulcers are surrounded by hemorrhagic infiltration.

Amœba coli, from 15 to 30 μ in diameter, *i. e.*, somewhat larger than a leukocyte, with a clear outer zone and granular protoplasm within. The cell-body contains vacuoles and a nucleus. The ameboid movements are readily seen when the organism is examined on a warm stage.

Abscess of the liver is an occasional sequel of amebic (tropical) dysentery.

What are the intestinal changes in chronic enteritis?

At first the changes are hypertrophic: the mucous membrane and muscularis are swollen, polypoid elevations may be present, and the lymph-follicles, solitary and Peyer's patches, enlarged. Later these changes are replaced by atrophy.

Tuberculous enteritis: (a) What particular parts are usually involved? (b) Describe the degenerative changes. (c) In which direction to the axis of the gut does ulceration extend most rapidly?

The process begins in the solitary and agminated glands or on the surface of the mucosa. Caseation and necrosis lead to ulceration, which may be very extensive and involve the greater portion of the mucosa of the large and small intestine. In the ileum the Peyer's patches are chiefly involved, and the ulcers may be ovoid, but in the jejunum and colon they are usually round or *transverse* to the long axis.

What are the anatomic lesions in enterocolitis in children?

Catarrhal swelling of the mucous membrane of the ileum and colon, with inflammation and enlargement of the lymph-follicles, which is the characteristic lesion (follicular enteritis or dysentery). Ulceration takes place in most cases.

What diseases are attended with ulceration of the intestines?

Typhoid fever, tuberculosis, cholera Asiatica, dysentery, enterocolitis of children, syphilis (rarely), duodenal ulcer.

Differentiate between a typhoid ulcer and a tuberculous ulcer of the intestine.

Tuberculous.	*Typhoidal.*
Chronic.	Acute.
Long axis usually transverse.	Long axis usually longitudinal.
Floor thickened and studded with gray tubercles. Gray tubercles around the ulcer and on serous coat.	Floor thin; edges undermined.
Hemorrhage and perforation rare.	Hemorrhage and perforation occasionally occur.
Cause: Bacillus tuberculosis.	Cause: Bacillus typhosus.

What is the pathology of enterolithiasis?

An enterolith is a fecal concretion consisting of a nucleus of epithelial cells or mucus, surrounded by inspissated fecal matter and earthy salts. The most common seat is the appendix. Perforation sometimes results.

Name five nematodes.

Ascaris lumbricoides, Oxyuris vermicularis, Trichina spiralis, Ankylostoma duodenale, Trichocephalus dispar.

In melanosis originating in the small intestines, where are the secondary deposits most likely to be found?

In the liver.

What pathologic conditions are productive of icterus?

1. *Mechanical causes:* Occlusion of the bile-ducts by catarrhal duodenitis or cholangitis (catarrhal jaundice); by foreign bodies (gall-stones, parasites) in the ducts; by pressure of a tumor or aneurysm from without; congestion, abscess of the liver, hypertrophic cirrhosis, cancer of the liver, hydatid cysts.

2. *Toxic Causes:* Hemolysis plays an important rôle in the etiology of these forms, which occur in severe infections (pneumonia), yellow fever, acute yellow atrophy, and in phosphorus-poisoning.

Jaundice of the newborn is attributed to circulatory disturbances within the liver.

Describe the pathologic conditions in icterus.

Yellow discoloration of the skin and conjunctivæ from the presence of bile-pigment; the urine is brownish or greenish in color, and all the organs

and tissues of the body are bile stained. The intima of the blood-vessels shows the earliest signs of biliary infiltration. The biliary capillaries of the liver are distended with bile, and the hepatic cells more or less pigmented. The stools are clay-colored if the bile-ducts are obstructed, preventing the access of bile to the intestine.

Give the pathologic features of mechanical hyperemia of the liver (nutmeg liver).

The liver is large, the edges rounded, the color dark. The engorgement begins in the central veins, which on the cut surface appear deeply congested. Fatty degeneration or atrophy of the peripheral portions of the acini occurs secondarily. The contrast between the pale color of these portions and the dark, deeply congested central portions of the acini suggested the name nutmeg liver.

The *cause* of passive hyperemia is obstruction of the general circulation from cardiac or pulmonary disease, pleural effusion or thrombosis, or compression of the inferior vena cava.

What changes take place in simple atrophy of the liver?

The liver is uneven and diminished in size, or the atrophy may affect only the edges or certain portions of the organ. The liver-cells are smaller than normal, granular, and dark. Hyperplasia of connective tissue is not marked.

What changes take place in cyanotic atrophy of the liver? Give the microscopic appearance of this diseased condition.

To the changes of passive hyperemia (*q. v.*) are added hyperplasia of the connective tissue between the lobules and acini and intense pigmentation. The process is a secondary cirrhosis.

Classify and describe abscesses of the liver.

An etiologic classification is most satisfactory. The cause is always bacterial.

(a) Infection by way of the bile-ducts or by extension from the duodenum.
(b) Extension of suppuration from contiguous organs.
(c) Traumatic.
(d) Amebic dysentery.
(e) Pyemia.

Amebic abscess is usually *single;* both amebæ and pyogenic microorganisms are present, as a rule. *Pyemic* or *metastatic abscesses* are multiple; the primary focus is a pyelophlebitis in some adjacent organ.

Describe the pathologic histology of amyloid liver, and state where the deposit occurs.

See previous question.

The process begins in the connective tissue of the walls of the blood-vessels and spreads to the surrounding connective tissue and parenchyma. Both cells and intercellular substance are involved.

Describe the lesions found in the different forms of cirrhosis of the liver.

Three varieties are distinguished by systematic writers: (a) atrophic, (b) hypertrophic, and (c) biliary cirrhosis. The last two are sometimes described under the common name hypertrophic.

(a) *Atrophic Cirrhosis.*—See next question.

(b) *Hypertrophic Cirrhosis.*—The enlargement is uniform, the surface is smooth, the consistency hard, and the color yellowish or greenish and mottled. The interlobular connective tissue is hyperplastic, as in the atrophic form, but its distribution is uniform throughout the liver instead of 'periportal,' and there is little or no tendency to contraction. There is marked proliferation of the bile-ducts and also of the liver-cells, instead of atrophy. Obstruction of the portal circulation, if it occurs at all, is slight.

(c) *Biliary Cirrhosis.*—This form is due to chronic obstruction of the bile-ducts. The process begins around the finer ducts. The macroscopic appearance of the liver is practically the same as in hypertrophic cirrhosis. Microscopically, the first changes are spots of insular necrosis in the peripheral zones of the acini. The hyperplasia of connective tissue is conspicuous around the interlobular biliary capillaries (periangiocholitis), and multiplication of bile-ducts and liver-cells is marked.

The following differential table is from Thayer's 'Pathology':

Hypertrophic.	*Atrophic.*
Synonyms: Charcot's, hypertrophic, unilobular, hepatogenous, biliary.	Laennec's, atrophic, multilobular, hematogenous, hob-nail liver.
Jaundice: Early and marked; bile often absent from feces.	Late and slight; bile usually present.
Ascites: Late and unimportant.	May be early; often enormous.
Spleen: Enlarged early and markedly.	Late and less.
Alimentary hemorrhage, piles: Not common.	Common.
Liver: Large, smooth, mottled, green.	Small, rough, pale or yellow.
New fibrous tissue: In fine lines and strands between acini and cells, involving all parts equally.	In broad bands, making prominent islands in which the single acinus may appear nearly normal; distributed irregularly.

Describe the pathologic changes that take place in the liver from the effects of chronic interstitial hepatitis or atrophic cirrhosis.

After a transient stage of enlargement from congestion the organ becomes contracted, hard, and irregular on the surface ('hob-nail liver'). Hyperplasia of the interlobular connective tissue, and sometimes of the bile-ducts, is the characteristic lesion. On section, bands of connective tissue are seen surrounding the lobules or groups of acini, which appear yellowish or brownish and project from the surface. The connective tissue later contracts around the branches of the portal vein and obstruction of the portal circulation results. The organ is not necessarily reduced in size.

Microscopy.—Round-cell infiltration, formation of new connective tissue, multiplication of bile-ducts, and atrophy of liver-cells.

Give changes in liver in chronic alcoholism.

They are the same as those of atrophic cirrhosis (*q. v.*).

Give the pathologic difference between yellow atrophy, amyloid liver, and atrophic cirrhosis of the liver.

Yellow atrophy: The liver is small and soft, almost fluctuating; yellowish areas of fatty degeneration alternate with congested, red, hemorrhagic areas. Histologically, the principal change is an intense fatty degeneration; the nuclei disappear, and the cells are converted into fat-droplets. Blood-pigment and crystals of leucin and tyrosin are present.

The *amyloid liver* is uniformly enlarged, smooth, with rounded borders. The consistency is denser than normal, and the organ may pit on pressure. The color is 'waxy' or 'bacony.'

Microscopy.—The liver substance is translucent, cloudy, and grayish-white in color. The nuclei are destroyed. With Lugol's solution the characteristic amyloid reaction—a dark, reddish-brown color—is obtained.

Atrophic cirrhosis: The liver is hard and the surface irregular. It cuts with difficulty, revealing the hyperplastic bands of connective tissue around the lobules, which project from the cut surface. The color is not markedly altered. The liver-cells are atrophied, particularly at the periphery of the acini; round-cell infiltration is conspicuous, and there is some proliferation of bile-ducts (see page 597).

Give the possible causes of occlusion of the bile-duct.

Catarrh of the bile-duct itself or of the duodenum; the presence of gall-stones or parasites (ascaris, coccidia), pressure of a tumor, aneurysm, or floating kidney from without; malignant disease involving the duct; adhesions and cicatricial contraction.

Describe the pathogenesis of gall-stones and the physical and chemical characteristics of one variety.

The formation of gall-stones is attributed to two causes: (a) the presence of a nucleus—a mass of epithelial cells cast off from the walls of the bile-duct, mucus, or a foreign body; and (b) change in the composition of the bile, resulting from stagnation. The bile becomes inspissated and precipitates cholesterin, which is deposited around the nucleus and forms the stone. Bacteria are sometimes found in the center of the nucleus and represent the primary cause in some cases.

Most gall-stones consist of the above-described nucleus and cholesterin, sometimes with an outer coat of bile-pigment. The entire calculus may consist of biliary pigments in combination with calcium salts. Some calculi consist entirely of calcium carbonate.

What is an Eck fistula?

An Eck fistula is a fistula established artificially between the portal vein and the inferior vena cava so as to prevent the metabolic action of the bile upon the absorbed food.

DISEASES OF THE GENITO-URINARY ORGANS

What abnormal organic ingredients are found in the urine in chronic morbus Brightii?

Small quantity of albumin; hyaline and granular casts; renal epithelium; leukocytes, and sometimes red blood-cells.

Name the varieties of urinary renal casts, describe the characteristics of each, and state of what forms of renal disease they are a part.

Hyaline.—Tube-casts consisting of an albuminous material resembling the substance formed in amyloid and hyaline degeneration. *Waxy* casts are a special variety. They are found in chronic interstitial nephritis.

Cellular.—Hyaline casts with cells or cellular débris attached—(a) epithelial, (b) blood, (c) pus-casts. They signify parenchymatous nephritis.

Granular.—Degenerated cellular, especially epithelial, casts. They signify chronic disease; when abundant, chronic parenchymatous nephritis.

Distinguish between hematuria and hemoglobinuria. State the causes of each.

Hematuria.—Blood in the urine derived from any part of the genito-urinary tract. Causes: Renal congestion or hemorrhagic nephritis; traumatism; calculus; tumors; severe anemia; infections and intoxications.

Hemoglobinuria.—Free hemoglobin, without blood-corpuscles, in the urine. Causes: Infectious diseases (malaria); poisoning with potassium chlorate, carbolic acid, arsenic, toadstools, snake-bite; there is also an idiopathic form, so-called 'intermittent hemoglobinuria.'

Distinguish between fatty degeneration and fatty infiltration of kidney.

Infiltration.	*Degeneration.*
Size increased.	Size diminished. Specific gravity diminished.
Fat-granules have a tendency to coalesce and form large droplets; the protoplasm and nucleus are pushed to one side, but do not break down.	Fat in granules completely fills the cells, which eventually break down.

Describe the structural changes in the condition of the kidney which frequently accompanies chronic suppuration.

The *amyloid kidney* is enlarged, sometimes to double its size, harder than normal, and the cut surface is grayish or waxy, or mottled red and yellow (fatty degeneration). The process begins in the blood-vessel of the tufts and spreads to the connective tissue, but does not affect the cells. The capsule is thickened. Fatty degeneration of the epithelial cells develops sooner or later. The tissues give the amyloid reaction.

Describe the microscopic appearances of acute parenchymatous nephritis.

Cloudy swelling of the cells of the convoluted tubules; the nuclei cease to stain and the cells break down, to be replaced by new cells; the tubules are filled with an albuminous material and cellular débris, forming tube-casts. In some cases the glomeruli are chiefly involved (*glomerulo-nephritis*); the capsule of Bowman is thickened and the tuft contains large numbers of nuclei. When the collecting tubules are chiefly involved, with desquamation of the epithelium, the term *catarrhal nephritis* is used.

Describe the pathologic characteristics respectively of exudative and productive renal degeneration.

Exudative.—See Acute Parenchymatous Nephritis (preceding question).

Productive or Chronic Parenchymatous Nephritis.—The organ is described as the 'large white kidney'—pale on section, yellow areas of fatty degeneration surrounded by reddish zones. The capsule strips readily.

Microscopy.—Fatty degeneration of the cells of the convoluted tubules especially. The urine contains epithelial and especially granular casts in abundance, and fatty casts.

What abnormal products may be found in the urine as the result of (a) diabetes, (b) acute parenchymatous nephritis?

(a) Sugar (glucose), acetic acid (aceto-acetic acid), acetone, and β-oxybutyric acid.

(b) Albumin, usually in abundance; tube-casts of all kinds, especially epithelial and blood-casts; epithelial cells from the tubules; leukocytes and red blood-cells.

Describe the gross appearance of the kidney in chronic interstitial nephritis.

The organ is small, the surface irregular, in places retracted and covered with cysts; the capsule strips with difficulty. The kidney substance on section is firm and light in color; the thickness of the cortex is diminished. The blood-vessels are sclerotic.

Give the pathology in contracted kidney.

The contracted kidney is hard, small, red, and granular; the capsule adherent. There is a diffuse chronic inflammation; the cortex is very thin, the pyramids reaching almost to the surface. The greater portion of the parenchyma is replaced by indurated fibrous tissue. Many of the glomeruli have disappeared, leaving only fibrous cicatrices, finely granular masses, or hyaline balls. The tubules atrophy, the epithelium disappearing in many of them, while in others it separates from the basement membrane and lies as a loose cylinder or tube-cast in the lumen of the tubule. The blood-vessels are sclerotic.

Classify and describe briefly the cysts of the kidney.

All cysts of the kidney, from a simple cyst to the congenital cystic kidney, are due to a developmental error, or lack of union between convoluted and straight tubules. The usual classification is: (1) *retention cysts*, occurring in contracted kidney; (2) *solitary cyst*, supposed to be due to the coalescence of a number of small cysts; (3) *hydatid cysts;* (4) *congenital cystic kidney*, in which the kidneys may be very large and the parenchyma replaced by numerous large multilocular cysts; (5) *hydronephrosis*, a condition resulting from ureteral obstruction, and sometimes classified among the cysts of the kidney.

In what diseases is the spleen found to be enlarged?

Chronic heart disease, typhoid fever, malaria, septicemia, typhus and relapsing fever; sometimes in pneumonia, scarlet fever, and small-pox; syphilis; leukemia and pseudoleukemia.

Describe the structural changes of prostatic hypertrophy.

Uniform or nodular *enlargement;* usually the middle lobe or isthmus enlarges and presses upon the urethra. Microscopically, the fibrous and muscular tissues are proliferated, producing induration and the appearance of fibromyoma of the uterus. Sometimes the *glandular portions* are chiefly involved and the appearance is that of adenoma. *Cystic softening* may occur.

Describe the pathologic changes as regards the urinary tract one would expect to find in a case of hypertrophy of the prostate of long standing.

Acute interstitial nephritis or suppuration of the kidney (surgical kidney). The urine, owing to the obstruction of the urethra, stagnates and becomes infected with bacteria, which travel up against the current. The pyramids are chiefly affected and a catarrhal nephritis is produced, followed by suppuration of the entire organ.

DISEASES OF THE NERVOUS SYSTEM

Describe the pathologic conditions in meningitis.

The blood-vessels are dilated, the arachnoid is edematous, and the cavity filled with an effusion of serum, sero-fibrinous fluid, or pus.

Give the gross pathologic anatomy of cerebral apoplexy.

Rupture of one of the branches of the middle meningeal artery. The vessel is usually sclerotic and the seat of miliary aneurysms. The blood is poured out into the brain substance and produces acute softening; the softened tissue is later absorbed, and a cyst or scar remains.

What conditions (non-traumatic) favor cerebral hemorrhage? Mention the vessel from which cerebral hemorrhage occurs most frequently.

A high arterial tension and general arteriosclerosis; hypertrophy of the heart; miliary aneurysms of the cerebral vessels; brain tumor (increased blood-pressure); leukemia and pernicious anemia.

The lenticulo-striate artery on the left side.

What vessels are most commonly involved in cerebral hemorrhage? in cerebral embolus?

The branches of the middle meningeal artery that supply the internal capsule, striate body, and optic thalamus, especially the *lenticulo-striate artery.*—The artery of the Sylvian fissure and, less frequently, the anterior cerebral artery.

What pathologic changes may result from cerebral hemorrhage?

Softening, porencephalus, hematoma, cyst, or a scar. The voluntary muscles on the side opposite to that of the hemorrhage atrophy (*hemiplegia*); secondary degeneration and sclerosis develop in the interrupted nerve-fibers.

Describe the local appearances in a case of embolism of the middle meningeal artery.

A thrombus is found occluding the vessel from the seat of embolism to the first collateral branch. Infarction, ending in cerebral softening (encephalomalacia), is usually present.

Give the causes and process of cerebral softening.

Causes.—Hemorrhagic or anemic infarct; gradual compression by tumors or displaced vertebræ; traumatism; the toxins of tetanus, rabies, and other infectious diseases.

Infarction results from obstruction of a cerebral artery by a thrombus or embolus. The wedge-shaped portion supplied by the occluded vessel becomes anemic, undergoes liquefaction necrosis, and is ultimately replaced by a cyst or scar.

What are the pathologic appearances of anemia of the brain?

The brain is pale and firm, the difference in color between gray and white matter is less distinct than in a normal brain. The small veins have little tendency to bleed on section. The convolutions are shrunken.

Where and what are the pathologic changes in bulbar paralysis?

A primary degeneration of the motor ganglion-cells in the medulla, affecting the nuclei of origin of the facial, hypoglossal, spinal accessory, and vagus nerves.

Mention the syphilitic lesions of the brain and of the spinal cord.

Brain.—Gumma; diffuse endarteritis, with secondary sclerosis.

Spinal Cord.—Gumma; endarteritis, and posterior sclerosis.

By examining the fluid removed by lumbar puncture, how may we distinguish between tuberculous and other forms of meningitis?

The cellular constituents of the fluid in tuberculous meningitis are chiefly *lymphocytes*, and the presence of tubercle bacilli may be demonstrated by staining a smear or by animal inoculation. In other forms the fluid is turbid and the leukocytes are of the polymorphonuclear type. Pneumococcus, *Diplococcus intracellularis meningitidis*, or other bacteria may be present in the fluid.

Give the pathology of tabes dorsalis.

A primary ascending degeneration of the posterior columns of the spinal cord, involving the whole of the column in the lumbar region. Higher up, the affected area is more median, and in the cervical portion the column of Goll only is affected. Amyloid bodies may be found in the sclerotic areas. Changes in the optic tract and oculomotor nerve and trophic lesions of the joints (arthropathies, Charcot joints) are also present.

Give pathology of acute anterior poliomyelitis.

The anterior horns are red and the seat of minute hemorrhages; the tissue is soft; the blood-vessels are dilated and surrounded by round-cell accumulations, which are found throughout the affected tissue. The ganglion-cells degenerate and ultimately disappear.

What part of the spinal cord is involved in progressive muscular atrophy?

The ganglion-cells of the anterior horns and of the motor tracts, especially in the cervical region (the peripheral motor neuron).

Give some of the causes (pathologic) of general paralysis of the insane, or paresis.

Thickening of the meninges; edema of the pia; internal hemorrhagic pachymeningitis; increase of the cerebrospinal fluid; thickening and hyaline degeneration of the blood-vessels (endarteritis) of the cortex.

What is meant by the term Erichsen's disease or railway spine?

A neurasthenic or hysteric condition following shock and due to inflammation of the meninges and cord.

Give the pathologic changes in sclerosis of nerves.

Hyperplasia of the neurogliar tissue; atrophy and degeneration of the myelin sheaths and axis-cylinders, and thickening of the walls of the blood-vessels.

THE MUSCLES

Describe the changes that occur in degeneration of muscle.

Several varieties of degeneration are recognized as occurring in muscles.

In *parenchymatous* degeneration the fibers are cloudy and the striation is replaced by a granular appearance. Inflammatory changes in the interstitial connective tissue are also present.

In *fatty* degeneration the fibers are filled with droplets of oil which obscure the striation and produce a streaked or spotted, yellowish appearance. Finally the fibers are completely converted into fat-droplets and detritus.

Coagulation-necrosis or *hyaline degeneration:* The first changes are the same as in parenchymatous degeneration, and later the fibers are converted into a waxy or hyaline material. Transverse fragmentation occurs. The connective tissue shows inflammatory changes.

Calcification gives rise to ossifying myositis, and *amyloid degeneration* is described.

What are the alterations or changes that take place in a muscle while undergoing progressive muscular atrophy?

Fragmentation, coagulation necrosis, or fatty degeneration. The muscle-tissue appears pale and flabby; the connective tissue is increased and still further encroaches on the muscle-fibers. Proliferation of muscle-cells may also take place.

METABOLIC DISTURBANCES

What structural changes take place in chronic gout?

Arteriosclerosis, hypertrophy of the left ventricle, and myocarditis; a variable degree of cirrhosis of the liver and kidneys (small red kidney). Deposition of sodium urate in the articular cartilages (knuckles, ear) is the characteristic change; these deposits are called *tophi*. The joints are enlarged and the seat of inflammatory changes (fibrous overgrowth), causing deformities.

What condition of the blood is generally prominent in all forms of gout?

Excess of uric acid in the blood.

What are the usual pathologic lesions in diabetes mellitus?

Arteriosclerosis and interstitial nephritis (gouty kidney); cirrhosis of the liver; skin eruptions—eczema, furuncles, and carbuncles; gangrene of the extremities; pancreatic disease.

Describe the pathologic conditions present in each of the forms of goiter.

Parenchymatous or Simple Goiter.—Hyperplasia of the glandular tissue, either uniform or affecting only certain portions of the gland, with a tendency to degeneration. The amount of colloid material is usually increased—*colloid goiter;* the tumor may resemble adenoma—*struma adenomatosa;* it may be *cystic;* or the capsule and stroma may be increased in thickness at the expense of the glandular tissue—*fibrous goiter.* Calcification may occur.

Vascular Goiter (exophthalmic goiter, Basedow's disease).—Dilatation of the blood-vessels and sometimes hypertrophy of the glandular tissue. The gland as a whole is enlarged and pulsates. Associated conditions are tachycardia, exophthalmos, spasm of the upper eyelid (widening of the fissure), twitching movements of the eyeballs, lagging of the upper lid during downward rotation (von Graefe's sign); tremors of the hands; general vasomotor disturbances (flashes of heat, serous diarrheas, etc.).

Myxedema.—Functional or physical loss of the thyroid gland leads to myxedema, a metabolic disorder characterized by thickening of the subcutaneous tissues of the face, neck, and hands, due to the presence of a substance resembling mucin, tremor of the extremities, slowness of muscular movements and mental processes, and idiocy (*cretinism*).

What is cretinism, and with what is it associated?

A congenital or acquired condition characterized by myxedematous swelling, especially of the face, neck, and hands, slowness of speech and mental processes or idiocy, and general underdevelopment of the body. It is always associated with degenerative disease or absence of the thyroid gland.

THE NASOPHARYNX AND LARYNX

Describe and illustrate by drawing or otherwise the microscopic appearance of an adenoid.

A mass of lymphoid tissue composed of round-cells and held together by a small amount of connective tissue. Mucous glands are found in the deeper layers.

Describe the changes in tissue in two forms of nasopharyngeal catarrh.

Chronic Hypertrophic Nasopharyngitis.—The mucous membrane is swollen and reddened, the connective tissue, and sometimes the glandular and lymphatic tissue, is increased.

Atrophic Nasopharyngitis.—There is atrophy of the mucosa, the normal constituents being replaced by connective tissue; the ciliated epithelium disappears and is replaced by squamous cells.

What are the causes of stenosis of the larynx? Give the pathology of stenosis of the larynx.

Edema of the laryngeal tissues, so-called 'edema of the larynx,' more correctly *edematous laryngitis,* is an inflammatory edema due to intense irritation, general or local infection, or tuberculous or syphilitic ulceration and perichondritis.

Diphtheria.—The stenosis is due to the presence of the diphtheritic membrane.

Healing *syphilitic ulcers,* causing contraction of the larynx.

Carcinoma may produce stenosis.

Give the morbid changes taking place in acute edema of the glottis.

A better term is *edematous laryngitis.* The process is a true inflammatory edema, due to severe irritation or infection. The submucous tissue at the base of the epiglottis and over the aryepiglottic folds is greatly swollen and translucent or yellowish. The glottis is closed and asphyxia results unless the condition is relieved.

THE EYE

What are the pathologic conditions in gonorrheal ophthalmia?

Suppurative conjunctivitis with intense chemosis and a free purulent discharge; swelling and edema of the lids; corneal ulceration; perforation of the cornea; anterior leukoma; anterior staphyloma; hypopyon; panophthalmitis or atrophy of the bulb.

Describe the pathologic lesions which may result from a syphilitic or rheumatic iritis.

The iris is discolored and attached to the capsule of the lens by posterior synechiæ; the pupil-space may be covered with a false membrane, and in some cases inflammatory exudates are deposited in the anterior chamber. The condition is called *plastic iritis.*

Describe the changes that occur in the structure of the crystalline lens in cataract.

An opacity of the crystalline lens or its capsule or both. In persons under thirty-five years of age all cataracts are soft, *i. e.*, have no hard nucleus; after that age a hard nucleus is present. This is a most important distinction, for the former can be removed by needling (absorption), while the latter must be extracted—a more formidable procedure.

Give the pathology of retrobulbar neuritis.

Interstitial inflammation of the papillomacular fibers of the optic nerve.

THE SKIN

Mention the varieties of eczema.

Erythematous, papular, vesicular, pustular, and squamous; all other forms are subvarieties of these, as: eczema madidans or rubrum, rimosum or rhagadiforme, varicosum, verrucosum, marginatum, seborrheicum, etc. Certain regional varieties are also differentiated: eczema ani, aurium, barbæ, capitis, crurum, intertrigo, labiorum, mammarum, manuum (palmar eczema), pedum (plantar eczema), narium, palpebrarum, unguium. Universal eczema.

What anatomic changes take place in the skin in chronic eczema?

Cellular infiltration of the corium and sometimes of the subcutaneous tissue, dilatation of blood-vessels, hyperplasia of connective tissue, and enlargement of the papillæ.

What pathologic conditions are present to cause an acne rosacea?

Dilatation of the blood-vessels in the cutis, thickening and edema of the corium, marked hyperplasia of the connective-tissue elements of the cutis, and enlargement of the sebaceous glands.

Describe tuberculosis of the skin in any of its forms.

Lupus vulgaris is a chronic disease of the skin due to the tubercle bacillus and characterized by the development of brownish-red papules, tubercles, nodules, or infiltrated patches, which undergo absorption and ulceration and always leave scars. Lupus is a granuloma consisting of round-cell infiltration of the entire skin. Epithelioid, lymphoid, and giant-cells make up the granulations. Tubercle bacilli in small numbers are found in the tissues.

(a) Classify the micro-organisms causing tinea. (b) Is the fever termed enteric caused by the Bacillus typhosus?

(a) Trichophytosis, or tinea capitis and tinea circinata, is caused by the *trichophyton fungus.* (b) Yes.

What are the pathologic conditions causing favus?

The implantation and growth of *Achorion Schönleinii*, a mold, in the scalp and hair.

Name the characteristic parasite in each of the following diseases: favus, tinea versicolor, thrush.

Favus—Achorion Schönleinii.
Tinea versicolor—Microsporon furfur.
Thrush—Oïdium albicans.

Describe the causative agent and the production of the lesions of scabies.

The *Acarus scabiei* is about 0.5 mm. long and two-thirds as wide, with four pairs of legs, two on each side of the head, which is armed with suckers. The female, which is larger than the male, after impregnation bores a burrow in the deeper layers of the epidermis and there deposits her eggs. The young mites reach the surface of the skin, are in turn impregnated, and bore fresh burrows, thus keeping up the irritative and inflammatory process.

BACTERIOLOGY

Define bacteria; state (a) methods for recognition and cultivation; (b) the conditions most favorable for growth and the different ways of entering the body to produce disease.

(a) Bacteria are unicellular organisms of vegetable nature, devoid of chlorophyl, and multiplying by fission. They are recognized by their shape, size, motility, grouping, growth, behavior in different culture-media, and staining reactions. The chief culture-media are: milk, blood-serum, bouillon, gelatin, agar, potato.

(b) The conditions favorable for their growth are moisture, temperature between 10° and 40° C., nutritive material in the shape of decomposable organic matter, a medium of neutral or faintly alkaline reaction, and rest. Bacteria enter the body through the abraded skin or mucous membrane, or through the respiratory and alimentary tracts.

Give the classification of bacteria and name an example of each division.

Cocci: Streptococcus pyogenes aureus. *Bacilli:* Bacillus anthracis. *Spirilla:* Spirillum rubrum. *Mycobacteria:* Actinomyces.

What are the three basic forms of bacteria? Describe each by drawing or otherwise.

Cocci, bacilli, and spirilla.

Bacilli: rod-shaped bacteria—Bacillus tuberculosis. *Micrococci:* perfectly spherical bacteria—Staphylococcus pyogenes aureus. *Spirilla:* spiral, cork-screw forms—Spirochæte Obermeieri or spirillum of relapsing fever.

Define the following terms: (a) Coccus, (b) bacillus, (c) spirillum, (d) an obligative anaërobe, (e) facultative anaërobe. (f) Name one anaërobic organism.

(a) A spherical bacterium. (b) A rod-shaped bacterium. (c) A spiral or cork-screw-shaped bacterium. (d) A bacterium that grows only in the absence of oxygen. (e) One that grows best without oxygen, but will grow in the presence of oxygen. (f) Bacillus tetani.

(a) Name the pathogenic cocci. (b) Give the morphology; (c) method of staining of each. (d) Name the varieties usually found in the following diseases: (1) furunculosis, (2) tonsillitis, (3) purulent salpingitis.

(a) Staphylococcus pyogenes aureus, albus, and citreus, Staphylococcus epidermidis albus, Streptococcus pyogenes, Gonococcus, Diplococcus intracellularis meningitidis, Micrococcus tetragenes, Pneumococcus.

(b) Staphylococci are in irregular masses or clusters, like bunches of grapes; streptococci are in chains; gonococci are shaped like coffee-beans; diplococci are in pairs, of which the pneumococcus and Diplococcus meningitidis are types.

(c) They are all stained with Loeffler's methylene-blue, as follows: Make a film of the bacteria upon a clean cover-slip, dry, and pass three times through the flame to fix; pour on the methylene-blue, wash off after a quarter of a minute, dry, mount in balsam, and examine with $\frac{1}{12}$ oil-immersion objective.

(d) (1) Staphylococcus epidermidis albus. (2) Staphylococcus, streptococcus, and pneumococcus. (3) Gonococcus.

Define the following: (a) Bacteria; (b) pathogenic; (c) saprophytic; (d) leukocytes; (e) phagocytes; (f) opsonins. Describe the theory of phagocytosis.

(a) Minute unicellular vegetable organisms, composed of an albuminous substance called mycoprotein or cell-protoplasm, and sometimes surrounded by a capsule. (b) Capable of producing disease. (c) Bacteria that feed on dead organic matter and usually not pathogenic. (d) The white or colorless corpuscles of the blood. (e) Leukocytes (polymorphonuclear) and endothelial cells capable of taking up and devouring inert particles (pigments), and dead and living bacteria. (f) Substances contained in the blood-serum, which act on bacterial cells in such a way that the leukocytes are enabled to take them up and digest them by the process of phagocytosis.

Name the important pathogenic anaërobes.

Bacillus of malignant edema; Bacillus aërogenes capsulatus; Bacillus tetani.

What are pyogenic bacteria?

Micrococci that produce pus.

What is a diplococcus? Give the names of two pathogenic diplococci.

Diplococci are cocci or spherical bacteria occurring in pairs.

1. Diplococcus pneumoniæ or Diplococcus lanceolatus or Pneumococcus. 2. Gonococcus or Micrococcus gonorrhœæ.

Name the important pathogenic diplococci.

Micrococcus lanceolatus, Diplococcus pneumoniæ or Pneumococcus; Diplococcus intracellularis meningitidis (Weichselbaum); Micrococcus gonorrhœæ or Gonococcus.

Define the following terms: Germicide, antiseptic, asepsis, sterile, disinfectant.

A *germicide* is a substance which destroys germ life. An *antiseptic* retards or prevents the growth of septic organisms. *Asepsis*, absence of pathogenic or sepsis-producing organisms. *Sterile*, free from micro-organisms or spores. *Disinfectant*, an agent that destroys disease germs and the noxious properties of fermentation and putrefaction.

What are antiseptics? disinfectants? Give examples of each.

An *antiseptic* is any substance that inhibits the development of bacteria. *Examples:* bichlorid of mercury, carbolic acid.

A *disinfectant* is a substance capable of killing bacteria. *Examples:* formaldehyd, sulfate of copper, bichlorid of mercury in strong solution (1 to 1000).

Define aërobic, anaërobic. Differentiate facultative aërobic and facultative anaërobic.

Aerobic: The capacity of bacteria to develop in the presence of uncombined oxygen. *Anaërobic:* The incapacity of bacteria to grow in the presence of uncombined oxygen. *Facultative aërobic* organisms usually develop or grow in the presence of uncombined oxygen, but may develop under anaërobic conditions. *Facultative anaërobic* develop normally or usually in the absence of oxygen, but may develop in presence of uncombined oxygen.

Define and illustrate the terms obligate, pleomorphous, and sporogenous. Name and explain the two varieties of chemotaxis.

Obligate: Having no choice—obligate aërobe. *Pleomorphous* or *pleomorphic*—appearing in different forms under different conditions. *Sporogenous*—spore-forming.

Chemotaxis is the attracting or repelling force existing between ameboid cells, such as leukocytes (phagocytes), and food-particles or bacteria. If the cells are attracted to the food-particles, the term *positive* chemotaxis is used; if they are repelled, *negative* chemotaxis.

Define the following bacteriologic terms: Strict parasite, spore, flagellum, and mycelium.

A *strict* or *obligative* parasite is a bacterium that feeds exclusively on living organic matter.

Spore: A small, oval, highly refractive body which appears in the protoplasm of bacteria when the conditions of growth cease to be favorable and which is capable, in a suitable medium, of developing into a bacterium.

Flagella: Delicate, hair-like projections of the cell-membrane of bacteria which serve as organs of locomotion.

Mycelium: The growing or vegetative portion of a fungus (mold).

What is essential to the life of bacteria?

A suitable temperature, generally at or near that of the body; oxygen is generally needed; nutriment of a proper kind, containing both organic and inorganic material; a slight degree of moisture; a medium of slightly alkaline reaction; and rest. Some bacteria grow only in the presence of oxygen—obligative aërobes; some only in the absence of oxygen—obligative anaërobes; most pathogenic bacteria grow as well without as with oxygen—facultative anaërobes.

Give the functions and the products of bacteria.

Functions: Nutrition (absorption), excretion, growth, motion, and reproduction. *Products:* Fermentation—alcohol, acetic, lactic, and butyric acid; putrefaction—decomposition of nitrogenous substances with the pro-

duction of ptomains; pigment (chromogenesis); gases—CO_2, H_2S., NH_3; odors; disease (pathogenesis); acids; aromatic compounds—indol; phosphorescence; reduction of nitrates and formation of ammonia and nitrogen.

Name the different modes by which bacteria propagate.

(1) By direct or binary division or fission; (2) by sporulation.

What is a culture? How is it made? State its object? Why do you stain bacteria?

A growth of micro-organisms on a suitable medium in which large numbers are massed together. Cultures are made by means of Koch's plates, Petri dishes, and Esmarch's tubes. Several tubes containing gelatin are inoculated with the material containing the bacteria, forming *dilutions:* the first tube from the infected material, the second from the first, and the third from the second. The contents are then poured into the Petri dishes, which are placed in the moist chamber to develop. Aseptic precautions must be observed.

The *object* of making cultures is to isolate the different species of bacteria. In the third tube (dilution) the number of bacteria is so small that separate colonies, which do not coalesce, will develop where each organism falls.

Bacteria are *stained* in order to render them more easily visible for the purpose of studying them under the microscope, and sometimes for purposes of differentiation and identification.

Name five culture-media.

Gelatin, agar, potato, bouillon, and blood-serum.

What is a pure culture? Mention three of the most useful culture-media.

A growth consisting exclusively of one species of bacteria. Blood-serum; agar-agar; bouillon.

Discuss symbiosis with special reference to pathogenesis and cite example.

The virulence of bacteria is sometimes increased and sometimes diminished by the association in culture of other species of bacteria. For example, the toxin of Streptococcus pyogenes is much more virulent when obtained from a combined culture of Streptococcus pyogenes and Bacillus prodigiosus, while the pathogenicity of Bacillus anthracis is diminished by association in culture or symbiosis with Bacillus prodigiosus.

How do we determine whether a certain organism is or is not pathogenic?

To prove the pathogenicity of a micro-organism: (1) The micro-organism be found in the tissues, blood, or secretions of a person or animal sick or dead of the disease. (2) The micro-organism must be isolated and cultivated from these same sources; it must also be grown for several generations in artificial culture-media. (3) The pure cultures, when thus obtained, must, on inoculation into a healthy and susceptible animal, produce the disease in question. (4) The same micro-organisms must again be found in the tissues, blood, or secretions of the inoculated animal.

Give Koch's dicta (laws) regarding the bacterial cause of disease, and state whether these dicta (laws) are fulfilled in the following diseases: Typhoid fever, croupous pneumonia, diphtheria, measles.

See previous question.

Typhoid fever, no. Pneumonia, yes. Diphtheria, yes. Measles, no.

To what requirements must bacteria conform to be considered the cause of disease?

See above.

(a) What is the most effective method of sterilization? (b) How would you sterilize culture-media, and why?

(a) By *heat*—fire, dry heat or hot air, live (streaming) steam, superheated steam or steam under pressure, and boiling.

(b) By the *intermittent* or *fractional method* of steam sterilization. The culture-medium is exposed to the action of steam in an Arnold or other suitable steam sterilizer for fifteen minutes on each of three successive days. The first exposure kills all the fully developed bacteria; the bacteria which develop from spores in the course of the following twenty-four hours are killed by the next sterilization; and after the third exposure the medium is absolutely sterile. This method is employed for sterilizing culture-media because the prolonged exposure to steam required for the destruction of the spores would spoil the medium.

State method of sterilizing the following: fluid culture-media, test-tubes, rubber stoppers, rubber gloves.

Fluid culture-media, see previous question.

Test-tubes are exposed to 105° C. for one hour in a hot-air sterilizer.

Rubber stoppers and gloves are sterilized in nascent steam or boiling water, rendered slightly alkaline with sodium carbonate.

Give method of staining cover-glass preparations.

Spread the material in a thin film on a clean cover-slip, held in a suitable forceps; allow it to dry in the air, and fix by passing three times through the flame. Add the stain with a dropper, or place the cover-slip in a dish containing the stain for from two to three minutes, wash in water or alcohol according to the stain used, dry with filter-paper, and mount on a clean slide in water or Canada balsam.

Synopsis.

1. Spread material on cover-glass.
2. Dry in air.
3. Fix by passing three times through flame.
4. Stain two or three minutes.
5. Wash in water.
6. Dry with filter-paper.
7. Mount in Canada balsam.

Describe the mode of making cultures on potato.

The potatoes are scrubbed with a brush, washed with water and bichlorid solution, cut into cylinders with a cork-borer, the cylinders cut in two on the bias, leaving a long slanting surface, and placed in running water overnight. The tubes containing the half cylinders are sterilized by heating for three-quarters of an hour each day for three days, after which they are ready for use.

Describe in detail a bacteriologic procedure by which you could determine the fecal contamination of a water-supply.

Fecal contamination is revealed by the presence of typhoid and cholera bacilli. The former may be isolated by Pariette's method. To three test-tubes containing 10 cc. of bouillon, from 0.1 to 0.3 cc. of the following solution is added:

Phenol, 5 grains; hydrochloric acid, 4 grains; distilled water, 100 cc.

From 1 to 3 cc. of the water to be examined is added to each tube and the tubes are placed in the incubator. Only typhoid and colon bacilli will grow in this medium, and are then plated and separated for the purpose of counting the colonies. Bacillus coli communis is detected by making the fermentation test and counting the colonies (see also p. 624).

How would you proceed to find the number of bacteria per cubic centimeter in water?

Examine the specimen as soon after collection as possible. Plate cultures are made on gelatin, agar, or glycerin-agar. According to *Wolfhuegel's method* the Petri dish is placed on a large plate of glass divided into many small squares. The colonies in a given number of squares are counted with a hand-lens, and the number of bacteria per cubic centimeter estimated. *Parke's apparatus* consists of a black dish ruled with radiating, concentric white lines, printed on white paper. The Petri dish is placed over the disk, and the colonies are counted as they lie between the radiating and concentric lines.

Define amboceptors, bacterioproteins, lysins.

Amboceptors are antibodies having a double combining affinity, one linking on to the cell to be destroyed and the other linking on to the alexin or *complement.*

Bacterioproteins: Proteins produced within the bodies of bacteria.

Lysins: Substances formed in the blood-serum during bacterial infection which are bacteriolytic for the specific germ. They are probably identical with agglutinins.

Define toxins, antitoxins, ptomains, and leukomains.

Toxins are the poisonous products of pathogenic bacteria.

Antitoxins are substances formed in the body, of a protective character, and capable of rendering inert the poisonous products of bacteria.

Leukomains are basic chemical compounds, closely resembling the vegetable alkaloids, produced by the metabolic activities of the *organism.*

Ptomains are basic substances resulting from fermentative and putrefactive changes in the body set up by the metabolic activities of *bacteria.* Some ptomains are exceedingly poisonous.

What are (a) alexins? (b) leukomains?

(a) Certain soluble constituents of the blood to which its bactericidal power is attributed. The term was proposed by Buchner.

(b) Leukomains are animal alkaloids, basic substances, produced in the course of normal metabolism, and are poisonous. They are derived from the nucleus of the nuclei and the proteids of the cytoplasm.

Define immunity. What do you understand by natural, acquired, and inherited immunity?

Natural immunity: The insusceptibility of certain individuals and races to certain diseases at all times. The negro is immune against yellow fever; mice and rats are immune to diphtheria.

Acquired immunity is accidental or experimental. *Accidental* immunity usually results from an attack of an infectious disease, such as scarlet fever or small-pox; *experimental* immunity is always artificial, and is produced either by an attack of an infectious disease in a modified form, as in vaccination, inoculation with anthrax, cholera, etc., attenuated virus or cultures being used; or by the injection of specific antitoxins, substances found in the blood-serum of immunized animals which, when injected into another animal, confer immunity (diphtheria and tetanus antitoxin). The latter is called *passive*, the former *active*, immunity.

Inherited immunity is natural immunity inherited from one's parents.

What is infection?

Infection is an invasion of the tissues by pathogenic bacteria.

Describe the protective agencies by which the body guards itself against the entrance and harmful effects of pathogenic bacteria.

1. *Phagocytosis:* The devouring and destruction of pathogenic bacteria by certain cells (leukocytes and fixed connective-tissue cells) called *phagocytes*.

2. Phagocytosis depends in part on the presence in the blood-serum of certain substances called *opsonins*, which act upon the bacteria and prepare them for consumption by the phagocytes. The nature of these opsonins is not known.

3. The *bactericidal power of the blood-serum* and other body fluids, attributed to the presence of certain proteids called *alexins* or defensive proteids.

4. The production of substances capable of neutralizing the toxins of the bacteria that have invaded the body. These are called *antitoxins*, and their existence has been established in diphtheria and tetanus.

What are leukocytes, and what occurs when they come in contact with pathogenic bacteria?

Leukocytes are white blood-corpuscles. When they come in contact with pathogenic bacteria, if the conditions are favorable, they devour and destroy the bacteria (phagocytosis); sometimes, however, the bacteria manage to destroy the leukocytes.

What is phagocytosis? What is accomplished by it?

Certain cells in the body, chiefly leukocytes, possess the power of taking up and destroying bacteria by intracellular digestion. Metchnikoff, the

originator of the theory of phagocytosis, at first contended that the destruction of bacteria was accomplished solely by phagocytes; but when the bactericidal and antitoxic power of blood-serum was established by the work of Ehrlich and others, he modified his views to the extent that the phagocytes play only a contributory part in the process of immunization and destruction of bacteria.

Describe briefly Ehrlich's lateral=chain theory.

Ehrlich assumes for animal cells a complex molecular structure, represented by a central nucleus and numerous atomic *lateral chains* or *receptors*, each having its definite chemical or biologic affinity. Normally, the receptors exercise a selective function toward assimilable food-substances; pathologically, they are liable to the attack of specific toxins. The *toxin* unit also possesses at least two side-chains—a *haptophore* or fixation group, by which it may become united to the cell (*receptor*), and the *toxophore* or poisonous group, which is the active, disease-producing agent. When the receptor is seized by the haptophore of the toxin it is thrown out of function, and the organism is stimulated to produce new receptors, but in excess. This excess of receptors is thrown off in the blood, where it circulates as *antitoxin* and, the free receptors combining with the haptophores of the toxin, deprives the poisonous groups (toxophores) of access to the cells, thus permitting the latter to escape. Absence of receptors having affinity for (receptive to) the haptophores of the respective toxins is held to explain natural immunity from certain infections; while the special liabilities of certain tissues, as of the nerve-cells in diphtheria and tetanus, are assumed to be due to the predominance in those tissues of receptors suitable for the toxin in question.

Toxins that by age, heat, chemical action, or otherwise have become of lessened virulence are termed *toxones;* if deprived of their poison groups (toxophores), and thus rendered incapable of doing harm, they are termed *toxoids*. (Condensed from Cohen's *Physiologic Therapeutics*, vol. v, page 187.)

Discuss hereditary predisposition.

The physical basis of heredity is believed to be that the chromatin of the parent cell, during separation into two or more clusters to form the basis of new cells, undergoes an exact longitudinal division, so that the new nuclei share in the chromatin substance of the parent nucleus. By hereditary predisposition is meant a lack of resistance to certain influences (tuberculosis, neuropathic affections) transmitted from either parent to the offspring. While it plays a certain rôle in the etiology of disease, it is not so important as was formerly supposed. Constant association with a tuberculous subject is of greater significance than a family history of tuberculosis.

In what infectious diseases is immunization of value?

Small-pox and diphtheria.

(a) What is antitoxin? (b) What is serum therapy? Name two diseases in which it is applied.

(a) The term antitoxin is applied to a substance or substances in the blood-serum that protect against the toxin of a specific disease.

(b) The invasion of the body by certain pathogenic bacteria gives rise, after a time, to substances in the blood-serum which are deleterious to the

further growth of the invading organism. This principle is made use of in *serum therapy*. Thus, a horse is injected with the toxin of diphtheria bacilli, and in a given time his blood-serum will contain substances known as *antitoxin*. The injection of the horse's blood-serum (antitoxin) into a child suffering from diphtheria will give the child the benefit of the presence of these antagonistic substances, and thus neutralize the toxin before nature can produce them or before the child dies from excessive toxins. In the same way serum therapy is applied to tetanus. In this case the antitoxin must be given before the toxin has combined with the cells of the central nervous system.

(a) How is diphtheria antitoxin obtained? (b) Give the usual dose.

(a) A horse is immunized by successive injections of diphtheria toxin of such strength that 0.1 cc. will kill a guinea-pig weighing 500 grams. The first injection is 1 cc., and at intervals of eight days larger and larger doses, up to 300 cc., are given. The blood is received in sterile bottles and allowed to coagulate in the cold. The serum is removed with a pipet, an antiseptic (camphor, phenol, or trikresol) added, and the potency determined; 0.01 cc. antitoxin should neutralize 0.1 of toxin. A "*unit*" is the amount of antitoxin necessary to protect a 300-gram guinea-pig against 100 times the fatal dose of toxin.

(b) The usual curative dose is 5000 units.

What do you understand by the terms factor and unit as applied to antidiphtheritic serum?

A unit of antitoxin is that quantity of the serum that will neutralize 100 times the fatal dose of toxin required to kill a guinea-pig weighing 300 grams.

Factor is not a term used in connection with antitoxin.

State the dosage of diphtheritic antitoxin in pharyngeal and laryngeal cases, and in the different stages; also the dosage for prophylactic or immunizing purposes.

Authorities differ about the proper dosage in diphtheria. The following doses are conservative for a child six years of age.

Pharyngeal diphtheria—curative dose, 3000 units. Laryngeal diphtheria, 5000 units. Immunizing dose, 500 to 1000 units.

Describe in detail the mode of using antitetanic serum, and state the practical value of same.

For mode of administration see the next question.

The serum must be used early and in sufficient quantity, if it is to be of any curative value. Owing to the difficulty of making an early positive diagnosis in most cases of tetanus, antitetanic serum is practically of value only as an immunizing agent.

Describe four modes of administering antitetanic serum.

1. Subcutaneous injection.
2. Intravenous injection.
3. Injection under the dura mater through a trephine opening.
4. Dusting the desiccated and pulverized serum on the infected wound.

State the nature and the value of antistreptococcic serum.

It is an *antimicrobic* and *bacteriolytic*, not an antitoxic, serum. Streptococci whose virulence has been increased by passage through rabbits and intermediate cultivation are used to immunize horses, from which the serum is obtained (Marmorek's serum). The strength in units cannot be estimated as in the case of diphtheria antitoxin, and the dosage is, therefore, empirical. From 10 to 20 cc. are usually injected subcutaneously at short intervals. The serum is of limited value and only against infection with streptococcus. A bacteriologic diagnosis should always be made. Its use is indicated in erysipelas, streptococcus-suppuration, pyemia, puerperal infection, scarlet fever, and possibly small-pox.

Outline the serum therapy in bubonic plague.

Two serums are available for therapeutic purposes—Gersin's and the serum of Lustig and Galeotti. The dose recommended is from 5 to 10 cc., but very much larger doses of Gersin's serum are sometimes necessary. The best effects are said to be obtained by intravenous injection. The reports in regard to antiplague serum are not favorable. The British Commission appointed to investigate Gersin's serum found that it contained 'therapeutically useful substances in greater or smaller quantity.'

Give a general description of the action of agglutinins.

The serum of animals immune to a certain germ, as B. typhosus or B. choleræ, when added to a culture of the specific germ, produces the phenomenon known as *agglutination* (Gruber). The *agglutinins*, or agglutinating substances, first cause the bacilli to lose their motility; they then gather in clumps or bunches, and finally sink to the bottom as a flocculent precipitate. The phenomenon is seen in its most typical form in the Widal reaction of typhoid fever.

Give serum test (Widal reaction) for typhoid fever.

Blood-serum obtained from a typhoid patient, when mixed with a pure culture of typhoid bacilli, produces clumping or agglutination of the bacilli. The Gruber-Widal test is performed as follows: Either fresh or dried blood, obtained from a skin puncture, may be used; dry blood-serum is first dissolved in sterile water; fresh blood is diluted 5 to 10 times. A drop of the serum is placed on a cover-glass, a platinum loopful of eighteen to twenty-four hours' old bouillon culture of typhoid bacilli added, and the two thoroughly mixed. The drop is rimmed with vaselin and the cover-slip placed on a concave slide. A high-power ($\frac{1}{8}$) lens is used for the examination. The bacilli first lose their motility and, in about half an hour, when the reaction is typical, gather in bunches or clumps. The earlier the reaction, the more positive the diagnosis of typhoid fever.

What is the diagnostic value of Widal's test for typhoid fever?

Its diagnostic value is believed by some to be very great; others place little reliance on it. It may be absent in cases of typhoid fever; it may be present for several months after an attack; the reaction may not be obtained until the third week of the disease; it may be present in other diseases or in perfectly healthy persons. The above have all been urged as objections; certainly only positive results have any value at all.

In what disease, other than typhoid, do agglutination reactions occur?

Paratyphoid fever; epidemic dysentery (Shiga's bacillus); plague; cholera; Malta fever; glanders; pneumonia; tuberculosis (doubtful).

What is tuberculin? How is it produced? What is it used for?

A 50 per cent. glycerin extract of live tubercle bacilli cultures.

A flask is half filled with veal bouillon containing 4 to 6 per cent. of glycerin. The surface is inoculated with a pure culture of tubercle bacilli and the flask placed in an incubator for from six to eight weeks. The bouillon, after evaporation to one-tenth its volume over a water-bath, is then filtered, and this filtrate is *tuberculin.*

Tuberculin is used as a diagnostic agent. The injection of 1 to 5 mg. of tuberculin into a non-tuberculous individual is without appreciable effect; but in a tuberculous patient the same dose is followed by a decided reaction, characterized by elevation of temperature, headache, lassitude, at times nausea, vomiting, and chills.

Describe in detail the tuberculin reaction.

See previous question.

Calmette has devised a simple method of applying the tuberculin test. Tuberculin is precipitated with alcohol and the precipitate dissolved in sterile salt solution. One drop of this solution (1 per cent.) is instilled into the eye and, when the test is positive, an inflammatory reaction and a light grayish exudate appear in from six to ten hours. This is called by Calmette the *ophthalmo-tuberculin* test, and by Wolff-Eisner, who claims priority, the *conjunctival test.* Modifications of this test are the *percutaneous* or *cutaneous inoculation test* after v. Pirquet, in which the tuberculin is rubbed into the skin with a blunt instrument, and the *inunction test* devised by Moro.

These tests are still in the experimental stage. They are apparently very sensitive, and the percentage of reactions among non-tuberculous subjects is high.

Describe the tuberculin test and the opsonic test for the diagnosis of tubercular infection.

For the *tuberculin test,* see previous questions.

Opsonic Index Test.—Blood is drawn from the finger or lobe of the ear, as in making a blood count, and received into normal saline solution containing 1 per cent. sodium citrate, to decalcify and prevent clotting. The corpuscles are precipitated in the centrifuge, washed with normal salt solution, and again centrifugated until all traces of the citrate and serum are removed. To obtain the serum, the blood is collected in suitably bent glass tubes, which can be fixed in the centrifuge to separate the serum.

For the tuberculous test, cultures of tubercle bacilli are heated, ground in a mortar with salt solution, and centrifugated; or Koch's New Tuberculin may be used. By means of special capillary pipets equal quantities of washed corpuscles, bacterial emulsion, and the patient's serum are taken up, blown out together upon a glass slide, and mixed. The mixture is then drawn up into a small pipet, sealed, and placed in an incubator at

37° to 40° C. for fifteen minutes. A similar tube is prepared with normal serum or 'pool.' At the end of fifteen minutes smears are made from each tube, fixed, and stained with carbol-fuchsin. A good field is selected, the number of germs in the leukocytes in 50 or 100 fields is counted, and the average per leukocyte determined. The *opsonic index* of the patient's blood is found by dividing the average number of germs per leukocyte by the same number in the mixture with normal serum. Thus, if the average in the latter is two tubercle bacilli per leukocyte, the phagocytic index is 2; and if the average in the mixture containing the patient's blood is one per leukocyte, the opsonic index is ½.

Name some of the principal bacteria of the staphylococci and the streptococci groups.

Staphylococcus aureus, Staphylococcus albus, Staphylococcus citreus, Streptococcus pyogenes, Streptococcus erysipelatis.

What micro-organisms are most frequently related etiologically to the development of surgical septicemias?

Staphylococcus pyogenes aureus, albus, and citreus; Streptococcus pyogenes; Bacillus coli communis.

Describe in detail the bacterial findings in puerperal septicemia.

Staphylococcus and Streptococcus pyogenes albus and citreus; Bacillus coli communis; Pneumococcus; Bacillus aërogenes capsulatus, Bacillus pyocyaneus.

Classify morphologically the micro-organisms causing erysipelas, furunculosis, diphtheria, lobar pneumonia, and relapsing fever.

Erysipelas and furunculosis, micrococci; diphtheria, a bacillus; lobar pneumonia, a diplococcus; relapsing fever, a spirillum.

What bacteria are associated with inflammation and suppuration?

The most common are Staphylococcus pyogenes aureus, albus, and citreus and Streptococcus pyogenes. Bacillus pyocyaneus (blue pus), Pneumococcus, Friedländer's diplococcus, Bacillus coli communis, Bacillus typhosus, Gonococcus, Bacillus tuberculosis, and Bacillus epidermidis albus are rarer causes of suppuration.

Describe the microscopic appearance and the behavior of Staphylococcus pyogenes aureus in osteomyelitis.

Staphylococcus pyogenes aureus is a small, spherical organism, occurring singly, in pairs, or in clusters, and staining readily with methylene-blue. In *osteomyelitis* the micrococcus produces a primary infection and enters the bony structures through the circulatory system, gaining entrance at some remote point. After being deposited in these structures it sets up an acute, purulent inflammation that results in necrosis of the bone and surrounding tissues, which inflammation ultimately becomes chronic.

What are the essential factors in infective processes?

Infectious processes are caused by the entrance of bacteria and dissemination of the bacterial bodies or their toxins in the body. Clinically they are characterized by fever, acceleration of the pulse, so-called constitutional symptoms—anorexia, headache, chills, pain in the back and limbs.

Micrococcus lanceolatus: (a) Describe process of staining. (b) What is its significance and in what inflammatory condition is it often observed?

(a) Micrococcus lanceolatus is better known as Diplococcus lanceolatus, or Pneumococcus of Fränkel and Weichselbaum. For method of staining see page 626.

(b) It is found in about 75 per cent. of all cases of lobar pneumonia and has been found occasionally in cerebrospinal meningitis, pleurisy, peritonitis, endocarditis, acute abscesses, otitis media, and the sequelæ of croupous pneumonia. It is present in the saliva of healthy persons.

Describe the pneumococcus, and give its characteristic experimental reaction.

An oval coccus, usually occurring in pairs, and sometimes forming chains of 4 or 5 units. Pneumococci obtained from excretions or diseased tissue have a lance-shaped extremity and are surrounded by a *capsule*. The organism is non-motile, has no flagella, and does not form spores. It stains by Gram's method, being thereby differentiated from the gonococcus and the meningococcus. Milk is rapidly coagulated. It is a facultative anaërobe.

Differentiate between Pfeiffer's bacillus of influenza and the pneumococcus.

Pneumococcus.	*B. influenzæ.*
Gram positive.	Gram negative.
Possesses a capsule.	Has no capsule.
Facultative anaërobe.	Strongly aërobic.
Grows in ordinary culture-media.	Grows only on blood-serum and ordinary media when smeared with blood.

Describe the organism which is the cause of influenza. On what kind of culture-media will this organism grow?

B. influenzæ, discovered by Pfeiffer and Canon, is a very small, rod-shaped organism, occurring singly or in short chains, end to end. The extremities are somewhat swollen and stain deeply, producing a resemblance to diplococci or dumb-bell-shaped bacilli. They are non-motile. B. influenzæ grows on glycerin-agar and blood-serum.

Where is the influenza bacillus apparently constantly found? How are its effects induced?

It is apparently constantly found in purulent secretions of influenza cases as long as the disease lasts. It is also found in pneumonia, endocarditis, and other lesions following influenza.

Not much is proved. Filtered cultures are non-toxic. Its toxicity does not depend upon a soluble toxin, but is intracellular.

Where is gonococcus usually found? Describe its characters; give specifically a method of staining it.

The gonococcus attacks cylindric epithelium and is usually found in discharges from the urethra, conjunctiva, and rectum. It does not attack flat epithelium, hence gonorrhea of the mouth or nasal passages does not occur. A similar organism, Coccus catarrhalis, attacks these but does not attack the urinary bladder—gonorrheal cystitis is really gonorrheal prostatitis. Gonococcus attacks the reproductive, not the urinary, organs.

It is a diplococcus, biscuit shaped, usually found in pairs, and within the pus-cells, and cannot be cultivated upon ordinary media. Does not stain by Gram.

No stain is specific, but for a diagnosis it suffices to stain with dilute alcoholic solution of methylene-blue for one-half minute, mount, and examine. If organisms are found, stain by Gram: (a) solution anilin-gentian violet, two minutes; (b) Lugol's solution, until black. (c) Decolorize in alcohol. (d) Wash and counterstain with Bismarck brown, one-half minute. (e) Dry and mount. Gonococci are stained brown with Bismarck brown. This suffices for diagnosis usually; for an absolute diagnosis cultures are required.

What special culture-medium is required for the growth of the gonococcus? Give the pathogenicity of the gonococcus.

Blood-serum agar, consisting of 1 part of liquid blood-serum and 3 parts of agar. One part of human blood-serum and 2 parts of peptone-boullion also make a good medium.

The gonococcus is always found in the purulent discharge from gonorrheal inflammations anywhere in the body. It is never an inhabitant of normal mucous membranes. The gonococcus is said to have a tendency to remain latent in the tissues, retaining its full pathogenic power, and to renew its activity after a long period of latency.

Describe a tubercle bacillus.

A straight, rod-shaped organism, 1.5 to 3.5 μ long and about 0.5 μ thick, beaded, often occurring in pairs or groups. It is *acid-fast, i. e.*, stains with difficulty (carbol-fuchsin), and retains the stain with great tenacity.

With what bacteria found in milk may the tubercle bacillus be confounded?

The butter bacillus of Rabinovitch.

State where the smegma bacillus is found, and give the mode of differentiating it from the bacillus of tuberculosis.

Beneath the prepuce of man and between the labia of woman. It is differentiated from the tubercle bacillus by the fact that it is decolorized by absolute alcohol, and does not produce tuberculosis when inoculated into an animal, as it is a non-pathogenic germ.

Describe the leprosy bacillus.

A straight, slender rod, with rounded ends, a little shorter than the tubercle bacillus, to which it bears a close resemblance both morphologically and

tinctorially. It is non-motile and does not form spores. It is readily stained with anilin dyes and is not decolorized by mineral acids. It is cultivated with great difficulty. Leprosy cannot be transmitted to animals by inoculation.

Give the origin, morphology, properties, and growth of Bacillus tuberculosis, Bacillus anthracis, Bacillus œdematis maligni.

(a) See page 621. A purely parasitic, slender, rod-shaped, slightly curved, non-motile, non-flagellate, non-sporogenic, non-liquefying, non-chromogenic, aërobic, acid-fast organism. Grows on various media; disseminated in excreta from infected animals.

(b) A non-motile, non-flagellate, sporogenic, liquefying, non-chromogenic, pathogenic, aërobic bacillus, measuring 5–20 μ by 1 to 1.25 μ. Grows in threads. Cultivated on ordinary media.

(c) A motile, flagellate, sporogenic, anaërobic, liquefying, non-chromogenic, pathogenic organism found in the soil. It measures 2–10 μ by 0.8–1.0 μ.

Describe the Klebs-Loeffler bacillus and how do you stain for it?

About as long as the tubercle bacillus and twice as thick, with swollen ends. The shape is very inconstant: the bacilli may be straight or curved, uniform or irregular in size; they usually occur singly, with a tendency to parallelism. The organism is non-motile and has no flagella. Loeffler's alkaline methylene-blue is the stain usually employed. It also stains by Gram's method.

How would you differentiate the diphtheria bacillus from the pseudodiphtheria bacillus?

By animal inoculation; the pseudodiphtheria bacillus is not pathogenic.

Write the characters of the Bacillus anthracis, ray fungus, Bacillus typhosus.

B. anthracis: A long rectangular rod, 5 to 20 μ in length and 1 to 1.5 μ wide, with a tendency to form long chains; aërobic, non-motile, without flagella, and forming oval central spores. Stains with anilin dyes and by Gram's method. Cultivated easily on all kinds of media between 14° and 43° C. On gelatin plates characteristic opaque, grayish colonies with irregular borders develop in twenty-four hours. Liquefies gelatin slightly.

Ray fungus or *Streptothrix actinomyces* appears in the lesions as small, yellow granules from 0.5 to 2 mm. in diameter, consisting of a central granular mass from which radiate a large number of club-shaped threads. Stains with anilin dyes and by Gram's; aërobic; develops rapidly on all media at room temperature. The organism is a streptothrix, a high order of bacteria, not a mold, and is the cause of actinomycosis or lumpy jaw.

B. typhosus: A small, thick rod with pointed ends and terminal and lateral flagella; actively motile; 1 to 3 μ long by 0.5 to 0.8 μ wide, but very variable in size; does not form spores. Stains with difficulty with anilin dyes, which should be slightly warmed. It is facultative anaërobe; grows best at body-temperature; does not liquefy gelatin; produces an 'invisible growth' on potato.

Give the morphologic characters of the anthrax bacillus: first in blood, second in bouillon.

The growth on blood-serum is very sparse; the medium is slightly liquefied.

In bouillon the organisms develop rapidly, forming small flaky masses which settle to the bottom of the tube and leave the supernatant fluid perfectly clear. For morphology see preceding question.

How would you demonstrate the presence of anthrax bacilli in the kidney of an animal which had died of general anthrax infection?

A puncture of the organ is made and the fluid obtained is examined for Bacillus anthracis (*q. v.*).

Give the morphology of the tetanus bacillus; what are its toxins?

A slender rod, from 3 to 5 μ long, and about as wide as a red blood-cell, easily recognized by its drum-stick shape. The enlargement at one end contains a spore. It has no flagella and usually occurs singly.

Tetanotoxin, tetanin, tetanospasmin, and tetanolysin (Ehrlich).

Describe the specific organism of tetanus and state its peculiar culture characteristics.

See preceding question.

Gelatin is liquefied, agar is not; a moist, invisible growth is formed on potato; in bouillon it grows near the bottom of the tube and produces gas.

How does the tetanus bacillus induce its effects? Upon what theory is tetanus antitoxin administered?

By the production of toxins—*tetanospasmin*, which is the predominant poison and produces the spasms, and *tetanolysin*, a hemolytic substance.

The procedure is analogous to immunization against diphtheria. The aim is to neutralize the effect of the toxin in the body by the administration of an antitoxin. The linking of toxin and antitoxin of tetanus in the body is a subject still under discussion. While the toxin passes directly to the nerve-paths, the antitoxin injected subcutaneously is taken up by the blood-vessels by way of the lymph-vessels. A fatal dose of the toxin already taken up by the nerves cannot, therefore, be neutralized by antitoxin introduced subcutaneously; the substance must be injected directly into the nerves. The principal value of tetanus antitoxin at present is its prophylactic injection in cases of dirty wounds that present the probability of tetanus infection.

Describe the Bacillus typhosus and state (a) whether aërobic or anaërobic; (b) saprophyte or parasite; (c) facultative, strict or obligatory; (d) the manner of its action; (e) where found in body and how eliminated.

(a) A small thick rod with pointed extremities and from 10 to 18 terminal and lateral flagella, from 1 to 3 μ long and 0.5 to 0.8 μ wide; it does not form spores (see page 622). Facultative anaërobe with strong aërobic tendencies. (b) Both. (c) Facultative. (d) The germ enters the body through the

digestive tract and produces the characteristic ulcers in the Peyer's patches and solitary follicles of the small intestine. From here the bacilli make their way to other portions of the body, especially the spleen, liver, and kidneys, gall-bladder, and mesenteric lymph-glands. (e) The bacilli are found in the intestinal ulcers, the mesenteric lymph-glands, spleen, liver, kidneys, and occasionally the bladder. They are eliminated in the feces and sometimes the urine, especially during convalescence.

How would you secure a pure culture of the Bacillus typhosus?

Add 0.05 per cent. solution of phenol to each of several tubes of liquefied gelatin; inoculate the first with feces or a small piece of tissue from the spleen, mesenteric lymph-glands, or Peyer's patches of a typhoid cadaver; inoculate the second tube from the first, and the third from the second. The contents of each tube are then plated. The phenol prevents the growth of saprophytes, leaving only the typhoid bacillus and Bacillus coli communis to be differentiated; the latter appears some time before the typhoid bacillus.

Differentiate between Bacillus coli communis and Bacillus typhi abdominalis.

B. coli communis.	*B. typhi abdominalis.*
1. Produces gas in media containing glucose.	1. Does not produce gas.
2. On acid potato forms a smeary, elevated, circumscribed brownish layer, resembling that of typhoid on alkaline or neutral potato.	2. On acid potato produces an 'invisible growth' (at times the growth is yellowish or brownish)
3. Produces a marked acidity, and coagulates milk.	3. Does not coagulate milk, though producing a slight acidity.
4. Produces indol.	4. Does not produce indol.

Describe the comma bacillus and give the manner of its introduction into the system.

The comma bacillus or *cholera vibrio* is a small, slightly bent rod, with rounded ends and resembling a comma, or the letter S when two bacilli are joined end to end. It is motile and supplied with flagella; strongly aërobic; grows readily on all culture-media if they are slightly alkaline. Stains with some difficulty with anilin stains, best in hot carbol-fuchsin. It is Gram negative. It enters the body through the alimentary canal with contaminated water or food.

Classify (morphologically) the micro-organism of glanders, and give its pathogenicity.

A bacillus called *B. mallei*. It produces a small nodule resembling a tubercle, which finally softens and breaks down. The bacillus is found in the center of the nodule.

Define mallein.

Mallein is a product obtained from cultures of the glanders bacillus in the same manner as Koch's original tuberculin. A six weeks' old culture, grown in 5 per cent. nutrient glycerin veal-bouillon, is evaporated to $\frac{1}{10}$ its volume, and the result is *mallein*. It is employed as a diagnostic agent in the same way as tuberculin.

Describe the Bacillus aërogenes capsulatus.

A straight or slightly curved rod, of variable length and thickness, with rounded or square ends, encapsulated, as the name implies, non-motile, and without spores. The bacilli form long chains. Obligative anaërobe, growing best at body temperature and staining with anilin dyes and by Gram.

Gelatin is peptonized, but not liquefied. The growth is accompanied by the generation of gas.

(a) What is the natural habitat of Bacillus aërogenes capsulatus? (b) By what practical laboratory method would you determine the presence of this bacillus?

(a) The intestinal contents of most animals, sewage, garden and field earth, dust, milk.

(b) The suspected material is transferred to milk and incubated under anaërobic conditions for from forty-eight to seventy-two hours. One-half to 1 cc. of such a milk culture is injected into the ear vein of a rabbit, which is killed after three minutes. The body is placed in a thermostat for seven or eight hours, or kept at room temperature for from eighteen to twenty-four hours. At the end of this time it is bloated with gas, which, as it escapes through a puncture, may be lighted and burns with a bright blue flame. The bacilli are found in the organs in enormous numbers and are identified by their capsule, the absence of motility, their staining by Gram, and the formation of spores (Welch's method).

How would you recognize cerebrospinal fluid? How would you test it in tubercular meningitis?

Microscopically, normal cerebrospinal fluid contains a few leukocytes and a small quantity of granular matter; when it is purulent, it does not differ from the pus found in any other serous sac. (The source of the fluid is known in most cases and identification is rarely called for.)

Cerebrospinal fluid from a case of tuberculous meningitis contains an excess of *lymphocytes* (which are also present in excess in tuberculous sputum). The diagnosis may be confirmed by staining a fresh smear made from the centrifugated fluid for the tubercle bacillus; by making a culture on glycerin-agar, on which the tubercle bacillus will develop in from ten days to two weeks; and by inoculating a guinea-pig.

Mention five general or systemic diseases caused by micro-organisms, and in connection with each disease give the name and the chief morphologic characteristics of the organisms concerned.

1. *Tuberculosis.*—Bacillus tuberculosis, or Koch's bacillus (for description see page 621).

2. *Typhoid Fever.*—B. typhosus or Eberth's b., a short bacillus, 1 to 4 μ long and 0.5 to 0.8 μ thick, with plump, rounded ends, occurring in chains or cultures. It is flagellate and actively motile.

3. *Diphtheria.*—B. diphtheriæ or Klebs-Loeffler b., about as long as the tubercle bacillus and twice as thick, with swollen ends. Its chief characteristics are irregularity in shape and variation in staining. So-

called polar bodies, or Ernst bodies, are found at the ends, which stain more deeply than the body of the organism. It has no flagella, is non-motile, facultative aërobic, and does not liquefy gelatin.

4. *Tetanus.*—B. of tetanus, discovered by Nicolaier and Kitasato, a long, cylindrical rod, swollen at one end from the presence of a rounded spore. The rods, which resemble drum-sticks, usually occur singly; they may have flagella and are slightly motile. They are anaërobic and Gram positive.

5. *Relapsing Fever.*—Spirochæta Obermeieri, a spirillum 16 to 40 μ in length; flagellate and actively motile.

Name and describe the organisms most frequently associated with the following diseases: Typhoid fever, malarial fever (estivo-autumnal type), tuberculosis. Give method of staining each.

1. *Bacillus Typhosus.*—To stain, put a drop of distilled water on a clean slide with a sterile platinum loop, take a loopful of the culture and make an emulsion by rubbing it in the water; then spread it on a clean slide in a thin layer. Let it dry in the air and fix by passing three times through the flame. Cover the smear with Löffler's alkaline methylene-blue solution for thirty seconds; wash in water; dry; mount in balsam.

2. *Plasmodium Falciparum.*—Smear a drop of blood on a clean slide with another clean slide, allow to dry in the air. Cover the smear with Wright's stain, undiluted, and allow to stand for one minute; use plenty of stain—30 to 50 drops. Then add distilled water drop by drop until a brassy precipitate is seen on the surface of the stain; 8 to 10 drops of water are usually sufficient. Allow to stain five minutes. Wash with distilled water and allow distilled water to stand on the slide for one minute. Dry and mount in balsam.

3. *Bacillus Tuberculosis.*—For method of staining, see p. 627.

Name the organisms most frequently associated with each type of pleurisy and give in detail the method of staining of each organism.

From the bacteriologic standpoint, pleurisy is divided into the following:

Types.	*Bacterial Cause.*
1. Pleurisy secondary to pneumonia.	Pneumococcus.
2. Pleurisy secondary to tuberculosis.	B. tuberculosis.
3. Primary pleurisy without discoverable pulmonary tuberculosis (fibrous, sero-fibrinous, or hemorrhagic type).	Staphylococcus and streptococcus.
4. Purulent pleurisy or empyema.	Staphylococcus and streptococcus.

Other micro-organisms occasionally found in pleural effusions are: B. coli communis, B. typhosus, and B. anthracis.

Methods of Staining.—Spread the material on a slide or cover-glass as thinly as possible, dry in the air, and fix by passing three times through the flame. The specimen is now ready for staining.

Pneumococcus.—Stains with the anilin dyes and by Gram's method. Cover the film with the stain—alkaline methylene-blue or gentian-violet—and allow it to act for two to three minutes; wash in water, dry with filter-

paper, and mount in Canada balsam. To demonstrate the capsule, use Welch's method. Drop glacial acetic acid on the film from a pipet and allow it to act for a few seconds. Pour off the acid, without washing, and stain with anilin-water gentian-violet. Wash and restain until all the acid has been removed; then wash in 1 or 2 per cent. sodium chlorid solution and examine in the same medium.

Gram's Method.—Stain for a few minutes with anilin-water gentian-violet; pour off the stain, and immerse the specimen in Gram's solution:

Iodin crystals	1 gram
Potassium iodid	2 grams
Distilled water	300 "

Stain until the color is dark brown. Wash in 95 per cent. alcohol until color ceases to be given off, and the film is of a grayish color. Counterstain with eosin (one-half minute), wash in water, dry with filter-paper, and mount in Canada balsam. The pneumococci appear purplish or blue brown.

B. Tuberculosis.—Gabbet's Method.—Stain for from two to three minutes with Ziehl's solution, heating the cover-slip gently until steam is given off; wash off the excess, and stain for one minute with Gabbet's solution. Wash in water, dry, and mount in Canada balsam. Examine with a $\frac{1}{12}$ oil-immersion objective. The tubercle bacillus is stained a bright red, everything else blue.

Ziehl's solution:

Fuchsin	1 gram
Alcohol	10 grams

Dissolve and add 100 cc. of a 5 per cent. solution of carbolic acid.

Gabbet's solution:

Methylene-blue	2 grains
Sulfuric acid (25 per cent. aqueous solution)	10 cc.

Staphylococcus and *streptococcus* are stained with the anilin stains as described for the pneumococcus. They are also Gram positive.

B. coli communis and *B. typhosus* do not stain by Gram's method; *B. anthracis* is Gram positive. The ordinary anilin stains are used to demonstrate these organisms.

Give in detail a method of staining tubercle bacilli (a) in fluids, (b) in sections.

(a) See previous question.

(b) 1. Remove the embedding material. 2. Place the sections in Ehrlich's solution, twenty-four hours old, and allow to remain twelve to twenty-four hours at room temperature, or one to two hours in the incubator. 3. Place in water for ten minutes. 4. Transfer to a 20 per cent. nitric-acid solution for two minutes. 5. Wash in absolute alcohol, gently agitating the section until the blue color returns. 6. Wash in three or four changes of water until almost colorless. 7. Transfer to a slide with a section lifter, absorb the water with filter-paper, and heat over the flame until the section becomes shining. 8. Clear with xylol and mount in balsam.

(a) Describe in detail the examination of sputum for tubercle bacilli. (b) How would you make a bacterial diagnosis of diphtheria?

(a) The small "cheesy" particles in the sputum are selected for examination. One of these is picked up with a platinum loop or a tooth-pick and thinly spread on a cover-slip or slide. After drying in the air, the preparation is fixed by passing it three times through the flame. It is then stained as described above.

(b) A diphtheria diagnosis outfit, such as most boards of health supply, comprises a culture-tube containing blood-serum, a swab or inoculator in a sterile glass tube, and a wooden tongue depressor. The suspected throat or diphtheritic membrane, if present, is rubbed with the swab and the culture-tube inoculated. Swab and tongue depressor are immediately burnt. The culture-tube is placed in the incubator or the waistcoat pocket, and in from nine to twelve hours small white colonies make their appearance, from which smears are prepared. Stain as described on page 622.

Describe a method for distinguishing the typhoid bacillus in a post-typhoid abscess.

Make a culture from the pus, plate if necessary to obtain a pure culture, and inoculate tubes of lactose-agar, glucose-agar, and litmus-milk. The typhoid bacillus is identified by its motility, the fact that it does not ferment lactose-agar and glucose-agar, and does not produce acid in litmus-milk in twenty-four hours.

Tell in detail how to examine a suspected urethral discharge for gonococci.

Lightly touch the drop of discharge at the meatus with a cover-glass and prepare a smear in the usual manner. Stain one with Loeffler's methylene-blue and one by Gram's method. The gonococci are recognized by their characteristic biscuit shape, position *within the pus-cells*, and failure to stain by Gram's method.

Describe in detail the bacteriologic diagnosis of glanders.

Sections of tissue are placed in alkaline methylene-blue for five minutes and then in the following mixture for five seconds: Concentrated sulfuric acid 2 drops, 5 per cent. oxalic acid solution 1 drop, distilled water, 10 cc. Dehydrate in absolute alcohol, clear in xylol, and mount in Canada balsam.

Animal inoculation is more reliable. Inject the suspected material into the peritoneal cavity of a male guinea-pig. If B. mallei is present, the testicles soon break down and may discharge through the skin. On killing the animal, the tunica vaginalis is found full of fluid pus, from which pure cultures can be obtained. The bacillus grows best on glycerin-agar, blood-serum, and potato.

By what laboratory methods may rabies be diagnosed?

The virus of rabies is known to reside in the nervous tissues of the infected animal. An emulsion is made by rubbing up 1 centimeter of dried spinal cord from an animal dead of rabies with four or five times its bulk of bouillon. If this emulsion is injected into the veins of an animal, the symptoms of rabies make their appearance and the animal dies.

Give the bacteriologic diagnosis of actinomycosis.

Some of the sulfur-colored granules are removed from the tissues or the discharges, crushed between sterile glass slides, and inoculated on any of the usual media. Blood-serum and gelatin are liquefied. On all media a thick, dry, wrinkled membrane forms, which adheres firmly and cannot be removed without tearing it into shreds. The growth on potato is yellowish red. Milk is peptonized.

Name the portals of infection in (a) tuberculosis; (b) gonorrhea; (c) anthrax.

(a) Respiratory system and alimentary canal; the skin (rarely).
(b) Genital organs and the eye.
(c) Skin; occasionally the gastro-intestinal canal and the respiratory tract.

What are the causes of difference in the virulence of diphtheria?

The chief cause is the association of other pathogenic germs with the Bacillus diphtheriæ, such as Staphylococcus, Streptococcus, Pneumococcus, and Bacillus coli communis. The most virulent cases are those in which streptococci are present.

What pathogenic conditions may be produced by the colon bacillus?

B. coli communis is not positively known to be the cause of any of the diseases of the abdominal organs in which it is present. It is believed to be the cause of cholera nostras and cholera infantum, and has been found in many different infectious conditions, as puerperal fever, meningitis, abscess of the liver, endocarditis. The bacillus in these cases is usually associated with other bacteria.

Name the varieties of meningitis from a bacteriologic standpoint, and describe the elements you would expect to find in the fluid from a case of the epidemic variety.

Streptococcus-meningitis, tuberculous meningitis, pneumococcus-meningitis, and epidemic cerebrospinal meningitis due to Diplococcus intracellularis meningitidis (Weichselbaum), a diplococcus of the same shape as the gonococcus and also inclosed within the leukocytes and tissue-cells. It is non-motile, has no flagella, and does not form spores. It is very easily cultivated (differentiation from gonococcus).

Among the rarer causes of meningitis are staphylococci, Friedländer's Bacillus actinomyces, Bacillus typhosus, Bacillus coli communis, and Bacillus pyocyaneus.

Describe in detail the technique and state the value of blood cultures.

Wash the bend of the elbow with soap and water and scrub-brush, and rinse the soap off with water. Put a mercury bichlorid dressing 1 : 1000

on the bend of the elbow and keep it there for an hour. Then apply a tourniquet at the middle of the arm. Remove the dressing and tighten the tourniquet so as to cause the veins to stand out prominently, Then, with sterile hands, plunge the needle of a previously sterilized glass syringe of 10 cc. capacity into the median cephalic vein, supporting the vein between the thumb and finger of the left hand. When the needle is in the lumen of the vein, pull out the piston of the syringe and fill with blood. Withdraw the needle and inoculate three or four Erlenmeyer flasks, each of which contains 100 cc. of sterile bouillon, with from 1 cc. to 5 cc. of the blood. Incubate for twenty-four hours at 37° C. Dress the needle-puncture with gauze and collodion. Remove tourniquet.

The method is of value in the diagnosis of organisms producing acute ulcerative endocarditis and other septicemic and pyemic conditions, as Streptococcus, Staphylococcus, Gonococcus, Pneumococcus, Bacillus aërogenes capsulatus, Bacillus pyocaneus.—Bacillus typhosus is found in typhoid fever on the third or fourth day of the disease in about 80 per cent. of the cases, and can be differentiated from that of paratyphoid fever. The method is of value also in the diagnosis of pneumococcus and anthrax infections, bubonic plague, and sometimes acute miliary tuberculosis.

Give the bacteriologic findings in conjunctivitis.

The more common bacteria found in conjunctivitis are: Pneumococcus, Gonococcus, Diplobacillus of Morax-Axenfeld, Koch-Weeks Bacillus, Bacillus coli communis, Bacillus diphtheriæ, Staphylococcus, Streptococcus.

PROTOZOA

What are protozoa? Name three pathogenic protozoa.

A protozoön is an animal organism composed of a single cell.—Plasmodium malariæ, Entamœba histolytica, Trypanosoma gambiense.

What disease does the bite of an infected stegomyia fasciata produce (transmit)?

Yellow fever.

Name and describe the malarial parasites.

The malarial parasites are: (1) *Plasmodium vivax*, the cause of benign tertian malaria. (2) *Plasmodium malariæ*, the cause of quartan malaria. (3) *Plasmodium falciparum*, the cause of estivo-autumnal malaria.

A full-grown malarial parasite is composed of a *protoplasm*, which is circular when at rest, and irregular in outline when the pseudopoda are extended. This protoplasm is stained *blue* by all the ordinary blood-stains. Eccentrically placed there is a clear space, which represents the *nucleus*, and at one side of the clear space, when a polychrome methylene-blue stain has been employed, there is a red spot which is the *chromatin*. Embedded in the protoplasm of the parasite there are numerous reddish-brown granules of *malarial pigment*, which are in reality altered hemoglobin. In a fresh preparation the malarial pigment is seen to be in active motion and the pseudopoda can be seen actively extended and retracted.

Tell in detail (a) how you would detect malarial organisms in blood; (b) how distinguish between the quartan and estivo-autumnal parasite.

(a) Clean the lobule of the ear with alcohol. Puncture the ear with a sterile lancet. Take a small drop of blood, about as big as the head of an ordinary pin, on a perfectly clean cover-glass and drop it on a perfectly clean slide. Ring the edges of the cover-glass with vaselin to prevent evaporation and examine the specimen with the $\frac{1}{12}$ oil-immersion lens.

(b) The *quartan parasite* is sluggish of motion, the pigment-granules are large and dark. The red corpuscle containing the parasite is smaller than normal, and in the young forms the parasite lies in the equator of the corpuscle, producing so-called 'banding.' The rosette is found in the peripheral blood and has from 8 to 10 spores. The gametocytes are round.

The *estivo-autumnal parasite* is very active; the pigment is black and usually in one mass. The red corpuscle containing the parasite is shrunken and brassy in appearance. The rosette is almost never formed in the peripheral blood, but in the internal organs, and has from 6 to 12 spores. The gametocytes are oval in shape, forming the so-called *crescents*.

Detail the method of examination of fresh blood for the Plasmodium malariæ.

(1) Clean ear or finger with ether, and make stabs with a sterilized needle for blood. (2) Collect small drop upon clean, new cover-slip and invert upon clean slide—making a thin spread. (3) Use $\frac{1}{12}$ oil-immersion objective, plane mirror, and well-opened diaphragm. (4) Search carefully so as not to mistake crenated corpuscles. (5) Pigment must be dancing and the outline of the organisms must be plainly seen.

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